

[Faint, mostly illegible handwritten text, possibly a letter or diary entry, with some words like 'Girl' and 'Gyft' visible.]

1827

very warm weather on 31 October 1825

*Mary & Sarah sisters
in London of H. J. ...*

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SKETCHES
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ELEMENTS OF NATURAL PHILOSOPHY.

ACCOMPANIED WITH

SKETCHES

OF A

NEW THEORY OF THE EARTH.

BY

J. L. E. W. SHECUT,

Author of Flora Caroliniensis; of an Essay on the Yellow Fever of 1817; on Contagion and Infection; of Medical and Philosophical Essays; Elements of Medicine, &c. &c.

I labour to discover and to establish Philosophical Facts, which,
though they may be disbelieved, ARE STILL FACTS, THAT CANNOT BE
DISPROVED. Shecut.

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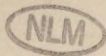
DISTRICT OF SOUTH-CAROLINA:

BE it remembered, that on the first day of November, Anno Domini one thousand eight hundred [Seal.] and twenty-five, and in the fiftieth year of the Independence of the United States of America, J. L. E. W. Shecut deposited in this office the title of a Book, the right whereof he claims as Author and Proprietor, in the words following, to wit:

"Sketches of the Elements of Natural Philosophy; accompanied with Sketches of a Theory of the Earth. By J. L. E. W. Shecut. I labour to discover and to establish Philosophical Facts, which, though they may be disbelieved, are still Facts, that cannot be disproved.—Shecut."

In conformity with the Act of Congress of the United States, entitled, "An Act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned." And also an Act, entitled, "An Act supplementary to an Act, entitled, 'An Act for the encouragement of learning by securing the copies of maps, charts, and books, to the authors and proprietors of such copies, during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving, and etching, historical and other prints."

JAMES JERVEY, District Clerk.



TO
SAMUEL L. MITCHILL, M.D., F.R.S.

&c. &c.

Professor of Natural History and Botany, of the University of the State of New-York.

DEAR SIR,

RECOGNISING in you, the honoured and independent veteran of Science—the venerable Father of American Geology—the distinguished Professor of Natural History and Botany, and the steady advocate and patron of the Arts and Sciences of our beloved country; I have been induced, as a testimony of the value of your profound attainments, to offer to your acceptance the following Sketches, or Outlines of Natural Philosophy, and of a Theory of the Earth. And with them be pleased to accept the renewed assurance of the continued esteem and veneration of

Your very sincere friend and fellow citizen,

J. L. E. W. SHECUT.

Charleston, Aug. 1825.

PRELIMINARY REMARKS.

AS this is a new view of certain principles of Philosophy, that have long been the subject of doubt and contention among systematists; there can be no apology necessary for the introduction of new terms, as the representatives of the principles thus introduced.

The literary world have been some years in possession of my views of the fluid, known as the electric fluid, originally advanced in the essays published in this city in the year 1819; and since enlarged and explained, in a course of lectures on the principles and properties of this fluid, as an agent in chemistry and medicine, delivered in the spring of 1821. By a reference to the printed copies of these works, it will be seen, that I had founded my principles and reasonings upon the popular opinions of the old school; which admits that there are two kinds of Electricity, and which those systems attempt to explain by the terms, *Positive* and *Negative Electricity*: that *Cold* and *Darkness* are neither of them positive substances; that *Oxygen* is the *alkalizing*, as well as *acidifying* principle of nature, &c.

Dissatisfied with the inconclusive and unsatisfactory attempts of those authors, to prove the foregoing positions agreeably to the established rules of sound philosophy; the author, in conformity with those rules, and upon the principles of the celebrated Professor O'GALLAGHER, determined on tracing as far as practicable, these subjects to their proper sources. Hence, he is induced to renounce his former opinions with regard to the foregoing positions; and has endeavoured to prove in the following sketches, the errors that have obtained in most preceding systems of philosophy.

The present system of Natural Philosophy, will be seen, to be the offspring of two theories that have engaged my attention for many years; and is the result of the most intense application, in investigating theories, and comparing facts that have resulted from the chemical analysis of nearly all the substances of nature. The theories alluded to are, first, "*Oxigene, or the Elements of Electricity*;" and, second, "*Geognosy, or a Theory of the Earth*;" the extensive bulk of these works have precluded the hope of my being able to put

them in print; on which account it has been suggested by my literary friends, that a distinct view of the principles upon which my theories are founded, would not only obviate the difficulty; but would in fact, be the means of introducing to the world, a condensed and systematic outline illustrative of both theories, and thus constitute an entire new chapter in philosophy.

To identify two admitted, and antagonist physical agents in nature, with the radiant imponderable ethereal substances of the firmament; and thence to establish the materiality of Darkness, and Cold; and to prove by reason and analogy, that *Oxygen*, or the acidifying principle of nature, is not also the alkalizing principle, and that negative electricity is *Magnetism*, are the primary objects of the present system. How far the author has been successful in supporting his arguments by reason and by facts, and his inductions by the results of natural and chemical analysis, the following pages will determine.

It may be proper, however, to observe, that the author claims no other share of originality in these Elements, than such parts as refer to the Agency of the Electric fluid; from which his Theory of Light and its qualities are derived, in connection with NITROGENE, or the ethereal firmamental principle of darkness, &c.; and his attempts to distinguish between the *acidifying* and *alkalizing* principles of nature. For the rest, he frankly acknowledges himself indebted to the host of luminaries, whose invaluable researches in natural history; in the various departments of science and philosophy, have afforded him such facilities, as to render the present a task more of pleasure, than of labour or of difficulty.

ELEMENTS OF PHILOSOPHY.

GOVERNING PRINCIPLES OF THIS SYSTEM.

I.

THE following axioms and rules for governing our investigations, and determining their results, have been selected from the best and most approved authorities, as the standard of the present system.

General Axioms.

I. "The Infinite Wisdom and Infinite Power of GOD, did in the Creation, bring forth all order of beings, perfect, according to their kinds, endowing each with the power and propensity adapted to its destination."

II. "As no want of materials, nor deficiency of skill, can be imputed to the SUPREME CREATOR, it is evident, both from reason and experience, that He has created originally one or more species of active matter, impressed with a certain invariable propensity to serve as *primary agents*, or *springs*, in the machinery of the universe."

III. "The agents thus created and endowed by Almighty Power and Wisdom, *are for ever* amply qualified for the performance of all their powers and propensities. And as for the production of every physical effect, He has provided a relative cause; He Himself being the Cause of all Causes; as it regards Himself all other causes are secondary: but as it regards nature in her operations; these permanent agents are primary, generative, and effective."

IV. The matters of the creation being separated according to "the fitness of things," and adapted to their respective destinations, by laws impressed upon them by their MAKER, are, according to these laws perpetual; that is, they continue their actions by those prescribed laws, with a regular succession of effects, which must and will continue, until it shall please Him to put an end to time."

V. "As a proof of the inherent and adequate powers and properties of the substances and agents of nature; when their Great Creator had finished the stupendous machinery of the universe, and had seen that all the parts were good and adapted to their destinations, 'He rested on the seventh day from all his work which He had made.—And GOD saw every thing that He had made, and behold, it was very good.' (Gen. i. 31.)"

From the foregoing axioms, selected from the "First Principles" of Professor O'GALLAGHER, of Dublin, it is evident that our author admits of one or more physical agents in nature that are amply endowed with powers and propensities adapted to their destinations. It remains, then, to consider the nature and extent of the powers prescribed to them by the CREATOR. But as these essences and powers are of that class which are termed imponderable, we have no certain method of investigating their properties and powers, as we shall shortly see, but by the phenomena, which we are enabled to prove, have been, and are continually produced by their influence. In order, therefore, to avoid falling into the usual error on these subjects, that of admitting imaginary powers along with established facts, we shall introduce the following axioms.

VI. It is a fundamental axiom among philosophers, that "In Natural Philosophy, *imaginary powers* are not to be admitted as facts, because nature is so simple and consistent in all her operations, that the attentive philosopher adhering solely to her laws, may trace every positive effect to its peculiar and specific cause, and these are facts by induction."

VII. "Physical agents are those which produce certain kinds of effects, but not their contraries, as fire can heat but cannot cool." The reasons assigned for this axiom are, that "If a physical agent be possessed of two equal opposite powers,

and these powers be at any one time equally exerted against each other, the agency in this case becomes suspended, or ceases altogether; and if one exerts a greater power than the other, the agency in this case is overcome, and is consequently ineffectual, and this would be contrary to what we have already observed with regard to the invariable powers and propensities of these agents, in Axiom IV. The following propositions are therefore necessary to be considered.

Prop. 1. "A physical agent cannot have two opposite propensities, or powers to produce contrary effects."

Prop. 2. "All the causes in nature are adequate and consonant to their respective effects, as are her powers to the modes of their respective operations; *i. e.* effects are as their causes, an old axiom."

Prop. 3. "Hence in nature, *material effects* must arise from *material causes*; material operations from material powers, and consequently immaterial or spiritual effects from spiritual causes; and (if we may say so) imaginary effects only from imaginary, or ideal causes." (O'GALLAGHER.)

From the foregoing axioms and propositions, I have been led to the adoption of the following self-evident axioms.

VIII. There were created by INFINITE WISDOM, TWO PRIMARY AGENTS IN NATURE, WITH OPPOSITE POWERS AND PROPENSITIES: *and these agents by their unceasing opposition, according to an universal and fundamental law of nature, tend to preserve the equilibrium of the universe.* (Introductory Lecture, p. 17.)

There are indeed many intermediate modifications of the powers and propensities of these agents; and their species, depending upon the relative predominance of one species above that of the other, instanced in all the great phenomena of nature. And in such cases, these phenomena are the effects of the antagonist actions of both agents in tending to restore an equilibrium.

IX. DARKNESS and COLD are the properties of one agent; while LIGHT and HEAT are the properties of its antagonist: so also *action*, or the centrifugal force, is the effect of one agent, while re-action or the centripetal force is the effect of its antagonist, according to Proposition 1st.

The two foregoing axioms are added as the result of my individual conclusions; and are to be received as *hypotheses*

until demonstrated and confirmed. They are however warranted from the following admitted fact.

"We may consider then, all bodies in nature as subject to the action of two opposite forces, the mutual attraction of their particles on the one hand; and the repulsive power of *caloric* on the other; and bodies exist in the solid, liquid, or elastic state, as one or other of these forces prevails." (Henry, Silliman, Hau.)

II.

Rules of Sir Isaac Newton.

Rule 1. "More causes of natural things are not to be admitted than are both true and sufficient to explain the phenomena; for, nature does nothing in vain, but is simple and delights not in superfluous causes of things."

Rule 2. "And therefore, of natural effects of the same kind, the same causes are to be assigned, as far as it can be done."

"As we have no safe method of investigating any cause, but by its known effects; when one cause is sufficient to explain the phenomena, we have no possible means of knowing that there are two or more; and therefore it is unphilosophical to assume the liberty of imagining, that there really does exist more than one cause of the effect." (Ewing's Comment upon Newton's Rules.)

Rule 3. (4th of NEWTON.) "In experimental philosophy, propositions collected from the phenomena by induction, are to be deemed (notwithstanding contrary hypotheses) either exactly or very nearly true, till other phenomena occur by which they may be rendered more accurate; or liable to exception. This ought to be done, lest arguments of induction should be destroyed by hypotheses."

I shall now proceed to the direct application of the foregoing axioms to the establishment of the present system.

III.

On the Creation of Primitive Light, or Origene.

"In the beginning GOD created the Heaven and the earth. And the earth was without form and void, and DARKNESS was upon the face of the deep." (Genesis i. 1, 2.)

From the heterogeneous combination of substances, or their essences in the mass preparatory to the formation of "the heaven and the earth," it is natural to conclude, that it assumed an appearance of darkness, and it was in this state without the active principles of light, heat or life; it was indeed emphatically "without form and void," until "THE SPIRIT OF GOD moved upon the face of the waters," whereby the entire chaotic mass became quickened, for, the CREATOR was about to lay the foundations of the universe, worlds were to be born, or created of the SPIRIT, and the GREAT CREATOR, to manifest Himself to his created.

"And GOD said, Let there be LIGHT! and there was Light." This first created substance, emanating from the influence of its CREATOR, and with an instantaneousness peculiar to it, sprang forth from the chaotic mass of gaseous fluids, and ushered in the twilight of creation: and the first grand and sublime phenomena of nature, was LIGHTNING, and in all probability accompanied with thunder; to this sublime fluid, I have applied the term OXIGENE.

As this Light was the first created substance in our system of worlds: so, was it also the FIRST GREAT PHYSICAL AGENT of the CREATOR for the completion of all the subsequent processes of the creation, and containing the principles of *motion* or *action*, &c. And this fact is developed by every process of nature, as will be seen in our progress with this essay.

"And GOD saw the Light, that it was good," that it was adequate to the purposes for which He had created it, possessing in itself the latent principles of *Light*, *Heat* and *Life*, derived from the vivifying influence of the CREATIVE SPIRIT: it is now pre-eminently qualified to act upon the remaining primordia of matter to effect the *expansion* and *rarefaction* of that portion destined to constitute the heaven, and the atmosphere of our globe.

IV.

Creation of the Etherial Principle of Darkness, or Nitrogene.

"And GOD divided the Light from the Darkness." The chaotic mass of fluids having been vivified or impregnated

with the principles of light, heat and life: and the great physical agent being thus constituted in the substance of *Primitive Light*; this agent in the plenitude of its powers, pervading the whole mass, which, by its subtilty and tenuity, penetrated to the centre, and became active in preparing these matters for separation; from whence may be considered to have originated that phenomenon, or law of chemical science, termed *analysis*, or the resolution and separation of substances into their constituent parts; and exemplified and established by that divine process in which it is said, "And GOD divided the light from the darkness."

This division or separation between the fluids of light and darkness, we shall shortly discover, was but partial and confined to the first principles of analytical resolution; and as preparatory to a further and more perfect separation of them for the formation of *solar light*, and from hence, I infer that the fluid matters of light and of darkness were still united, or blended, not chemically, but as it were mechanically, in the same manner that oil and water are blended when mixed together, their particles still remaining distinct.

The fluids thus partially separated from each other, constituted the TWO PRIMARY AND ANTAGONIST AGENTS OF NATURE, viz. *Primitive Light* and *Darkness*. In this conclusion, I have adhered to the "simple and consistent operations of Nature," as also to the axioms and rules for the government of philosophical investigations and conclusions; and the strict application of these principles, warrant the adoption of the simple and natural fact, that the ethereal principle of darkness, is the antagonist agent, to the ethereal principle of light.

I am further justified by the foregoing rules, in assuming as a fact, that the foregoing fluids thus partially separated, constitute the ethereal, firmamental matters of the universe destined to the formation of solar light, and as the necessary *pabulum* or fuel of the grand orbs that are shortly to cheer our globe, now in the dawn, or twilight of creation, with their refulgent and enlivening beams; while the remaining portion is to undergo further processes toward their entire and complete division or separation.

On the Creation of the Firmament.

“And GOD said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters.” (Gen. i. 6.)

The Firmament, which is elsewhere termed HEAVEN or EXPANSE, is unquestionably composed of those ethereal fluids, that are distinguished as the radiant imponderable and ethereal fluids of our Chemists and Naturalists, which are the same as the *ether*, *etherial fire*, *anima mundi* of the ancients; the *elastic species* of SIR ROBERT BOYLE; the *elementary fire* of BOERHAAVE; the *etherial medium* of SIR ISAAC NEWTON; and the *elastic matter* of Professor O’GALLAGHER. And the scriptural expression of the firmament, in the midst of the waters, dividing the waters from the waters, are to be explained by the actual chemical processes then carried on among the primordial matters of the creation.

By the expansive property of the primary agent, or ethereal fire, the division or separation of the ethereal and imponderable from the liquid and ponderable portions, explain the precise meaning of the words of the inspired historian, of “dividing the waters from the waters.” The ethereal portions that were to constitute the matters of the firmament, were expanded and rarefied; and by the *repulsive principle* of this agent, were made to diverge to every part within their limits in the universe, thus establishing the firmament or heaven of our system of worlds.

Air is admitted to be, water converted from its liquid to its *gaseous state*; hence the essential constituents of water, exist in the ethereal fluids of the firmament, and it is thus proved, that water may be either fluid, liquid or solid. We shall hereafter discover, that water even in its state of *gas*, is capable of holding in solution, particles of other substances, such as constitute the vegetable, animal and mineral kingdoms, and even metals.

VI.

On the formation of our Atmosphere and the Gases that are peculiar to its lower stratum.

By the extreme tenuity and penetrability of the primary

physical agent, it pervaded within and throughout the entire mass of the primordial matters; and from its characteristic property of inflaming such as were combustible, it inflamed or set fire to the *hydrogen gas*, and thus generating *material fire*. Whence the phenomena and laws of expansion and repulsion, which are the properties of *Fire*, were developed and established; and *Caloric* or the principle of Heat, assumed a character among the radiant imponderable and etherial fluids of the creation.

It must be admitted *a priori*, that the primordial matters of the creation were blended together in a state of fluidity intermediate between the liquid and gaseous states, constituting a chaotic cloud of dense vapour, and holding in solution the integrant essences or principles of those substances that were to be created, but, which were then and previously "without form and void." In the preceding paragraph, we have seen that, by the expansive property of the *etherial fire*, the fluids of the firmament were liberated from the chaotic mass, and by which, MOTION was induced into matter, now prepared for the chemical separation of the remaining portion of its primordia. It is presumable, that an immense proportion of the fluids, which had previously clothed these matters with *darkness*, had been displaced or separated from the mass, by their conversion to the etherial fluids above mentioned. Another large portion, less etherial and elastic, was converted into *nitrogen* and *oxigen*, as constituents of *atmospheric air*. Another portion, to *hydrogen*, &c. and no inconsiderable portion of the same fluids, entered into combination with the gravitating solids, that were attracted to each other by their affinities, and were now assuming a new form, and by a new law, or principle of attraction, termed the *attraction of Cohesion*, the property of the antagonist agent, which, by its *reaction*, converts these latter fluids to a state of solidity; when "GOD said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear." We may therefore consider, that it was in this state, and by these processes, that the nucleus of our earth was begun; and these conversions of the various proportions of the etherial fluids, account for the primitive subsidence of the waters of the ocean.

"Difficulties have been raised," says PROFESSOR MIT-

CHILL, "concerning the subsidence of the ocean. I have published nine years ago, my opinion that it must necessarily have diminished very considerably, for several reasons:—1. A great draught must have been made upon it to form the atmosphere. 2. Another and very great portion of it entered into the constitution of crystals, where it is solidified and embodied. 3. The bodies of vegetables absorb and confine a portion of it. 4. The bodies of animals consolidate or contain much more." (*Observations on the Geology of North America*, p. 409.)

The gases that are peculiar to the earth and the lower stratum of our atmosphere, consist of those substances that have combined with one or other of the species of the primary agents; and thus the following gaseous bodies have been formed:

1. *Simple Gases.* These are, *oxygen, hydrogen, nitrogen and caloric.*
2. *Compound Combustible Gases.* These are, *ammoniacal, carburetted-hydrogen, olefiant, phosphuretted hydrogen, hydro-phosphoric, sulphuretted hydrogen, arsenuretted hydrogen, &c. &c.*
3. *Acid Gases.* These are, *carbonic, muriatic, nitric, sulphureous, phosgene, silicated fluoric, and fluoboracic.*
4. *Gaseous Oxides.* These are, *carbonic oxide, nitrous oxide, and nitrous gas.*

These and other gaseous bodies are confined to the earth; and (with the exception of oxygen, hydrogen and nitrogen) to the lower stratum of our atmosphere.

VII.

On the formation and appearance of dry Land.

The impulse given to matter by the action of the primary agent, as remarked, (Sect. III.) is termed MOTION or ACTION; and the resistance which matter opposed to the impelling agent, by its antagonist is properly termed *re-action*. And to the action and re-action of bodies, through the influence of the antagonist agents, are to be attributed all the phenomena in nature. And while the one great physical agent is engaged in exacting the great draughts made upon the primordial mass of matters, as enumerated in the preceding section: its

antagonist is engaged in its coercive process, for consolidating a large portion of the more ponderable matters, converting them from a state of fluidity to that of solids, and hence producing the various strata of which the earth was then composed.

The ponderable matters of the creation gravitating to the limits assigned them, were made to cohere together, by the most powerful species of attraction, and without any cement; and this species of cohesive attraction, I consider to be one of the peculiar properties of the antagonist agent to light, as I shall hereafter more clearly prove. As an example, however, for the present: In the WERNERIAN arrangement of the formation of the earth, *Granite* is considered to be, for very strong reasons, the oldest, and consequently the primitive formation of our earth. "It is the lowest of all the formations, and the basis upon which the others rest. It is composed of *feldspar*, *quartz* and *mica*, each in a crystallized state, and cohering together without any cement." (THOMSON.)

By a reference to CLEVELAND'S, or any other mineralogical work, it will be found, that the *siliceous* and *aluminous* compounds, and of which the hardest and most perfect stones are formed, cohere together without any cement; and as *cohesion* is a principle the reverse of *expansion*, it is evident that the agents of these opposite principles must be distinct bodies. Many examples might be adduced, in support of the principle advocated in this section, the conversion of gaseous or fluid bodies to solid; but as some of these will form a separate section in this essay, I shall omit any further remarks on them in this place, and proceed to the conclusion of the present subject, the formation of primitive Earth.

I have already observed, (par. vi.) that all the materials of which the universe was to be formed, were held in solution by the primitive menstruum. This proposition is in accordance with the theory of the celebrated WERNER, and other *Neptunites*, who contend, that "At some former period this globe has, for a long time, been covered with water to a greater depth than the original altitude of the highest mountains. This immense body of water was then tranquil, or very nearly so, and contained in solution all the materials of which the present crust of the earth is composed. In this state, chemical deposites, exhibiting more or less of a crystal-

line structure, were gradually made, and invested the nucleus of the globe. These chemical deposits, constitute the *primitive rocks*, consisting of *granite, gneiss, mica, slate, &c.* and are distinguished by their crystalline structure, and by the total absence of organic remains. During this period, most of the highest mountains were formed; for their summits consist of primitive rocks."

"But by a gradual subsidence of the waters, the summits of the highest mountains were left naked; the tranquillity of the waters was disturbed; and currents were consequently produced. By these currents, the naked rocks would be worn and partially disintegrated; and the grains or fragments thus produced, would be diffused through the mass of water. The rocks formed at this period, would of course consist partly of chemical and partly of mechanical deposits. They would also lie over the primitive rocks; but in consequence of the diminished altitude of the waters, they would appear at a *lower* level, often resting on the declivities of primitive mountains—many of the rocks of this period, contain organic remains of marine animals and marine plants. As organic remains make their first appearance in the rocks of this period, it is supposed that the rocky shores which had recently emerged from the great deep, were passing to a habitable state," &c. WERNER, DE MAILLET, THOMSON, JAMESON, CUVIER, MITCHILL, CLEVELAND, and others.

It is therefore obvious, that the formation of Land was effected by the deposition and cohesion of the particles of earth which, continuing to gravitate to the centre, and accumulating incessantly; upon the subsidence or retirement of the ocean, according to the Scriptural expression, "Let the waters under the Heaven be gathered together unto one place, and let the dry land appear," is fully exemplified by the appearance of the summits of the highest mountains as expressed above.

VIII.

On the formation of Solar Light.

On this important subject, I must claim an almost unlimited indulgence, aware that I am entering into the investigation of principles that appear to have been fully established

by the great NEWTON, whose name alone is sufficient to deter from an attempt to add any thing to the splendid discoveries of that Prince of Philosophers; a patient and impartial consideration of the following arguments and deductions, will secure for me, an ample apology with the candid and sincere, not only for the additional observations on *Solar Light*, but also for the terms which I have necessarily used; as previously hinted at in the commencement of my preliminary remarks.

It will hardly be contended, that the primitive light, created on the first day; and that which the inspired historian informs us was created on the fourth day, were the same, it must be evident that there is a distinction in their formation, their characters and properties. Because, from the most rigid investigation, it appears, that primitive light is identified with the lightning of Heaven; a pure simple elementary substance, a latent or lambent fluid, or flame, without sensible heat, and as a primary physical agent, is incapable of decomposition; whereas, the *Solar Light* has been proved to be a compound substance, that has been decomposed by the illustrious NEWTON, who described it as exhibiting its constituents in the form of seven primitive or prismatic colours; and it has been since decomposed by every succeeding philosopher, with the same result, which must unquestionably establish it to be a compound light.

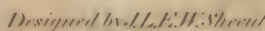
In my lectures on the Elements of Electricity, I have been at much pains in attempting to illustrate the constituents of solar light, and to point out the evident distinctions between it and primitive light. Subsequent investigations and more matured reflections, induce me to enlarge upon the subject in my Theory of the Earth; the mass of matter which necessarily accumulated, in its investigation at length assumed the character of a new and distinct theory; for the elucidation of which, new terms became indispensable, as may be seen in the following pages.

IX.

New Theory of Light.

The following *synopsis*, or scheme of the classification of the radiant, imponderable and ethereal fluids, is prefixed to

Spectrum.



For the Elements of Philosophy!

SCALE of supposed Combinations of Darkness and Light, with their products.

NITROGENE, or the principle of Darkness, in invisible Deoxidizing rays. Maximum of Darkness.			OXYGENE, or the Principle of light, in invisible Oxidizing rays.		
1. Violet ray. { 3 volumes of Nitrogen with 1 volume of Oxigene. }			{ Produce Frigoric, or the principle and Maximum of Cold. }		
2. Indigo ray. { 2 volumes of Nitrogen with 1 volume of Oxigene. }			{ Produce a Peroxide of Darkness. }		
3. Blue ray. { 1 volume of Nitrogen with 1 volume of Oxigene. }			{ Produce a Protoxide of Darkness. }		
4. Green Ray. { Oxigene, or the principle of Light uncombined, Positive Electricity, Maximum of Light. }			{ Nitro frigoric or the Solar De-oxidizing Rays. }		
5. Yellow Ray. { 3 volumes of Oxigene with 1 volume of Caloric. }			{ Produce a Peroxide of Light. }		
6. Orange Ray. { 2 volumes of Oxigene with 2 volumes of Caloric. }			{ Produce a Protoxide of Light. }		
7. Red Ray. { 1 volume of Oxigene with 3 volumes of Caloric. }			{ Produce a Peroxide of Heat, or the Principle of Heat. }		
			OXYGENE, or the Principle of light, in invisible Oxidizing rays.		

Remarks. It may be further supposed, that *Oxygen* is the result of the union of *Light* and *Caloric*, say in the combined quantities of the red, orange and yellow rays, as laid down in the above scale, which will amount to 6 volumes of Light with 6 of Caloric, and this combination is termed *Oxicaloric*, or the solar oxidizing rays, and is the principle of Actvity. And that *Nitrogen* is the result of the union of Darkness and Light, producing *Frigoric*, or the Principle of Cold. The combination of the quantities of the violet, indigo and blue rays, amounting to 6 volumes of Nitrogen with 3 volumes of Oxigene, result in Nitro frigoric, or the solar deoxidizing rays, and is the principle of ALKALINITY. Or, the rays may be distinguished as Electric and Magnetic.

Constituents of Solar Light.

(Constituents of Atmospheric Air. Electricity.....Magnetism.

the present theory, as explanatory of the terms adopted and used throughout.

CLASS I.

Radiant or imponderable etherial Fluids.

This class consists of the fluids distinguished as the *two great physical agents of Nature*, together with their respective species. It hence divides itself into two orders, correspondent to the division of the prismatic rays, as exhibited in diagram, Fig. 1, and the tabular view of their colours and proportions.

The first figure of the diagrams will be better understood, by supposing the outer confine of the *violet ray* to be occupied by the etherial principle of *Darkness*, and the outer confine of the *red ray* by the etherial principle of *Light*, in *invisible rays*; and that the central, or *green ray*, is the primary physical agent, *Origene*, occupying the same situation in the compound ingredients of solar light, that it did at the creation, when separating the light from the darkness; and lastly, that the intermediate and *visible rays*, are compounds of darkness and light, or *oxides*, formed by the admixture of the two *principles in the annexed* assumed proportions. [See Scale.]

The principles of the above are further explained in the classification following:

ORD. I.

Primary Etherial Fluids.

The fluids of this order are primary in nature, and are essentially qualified to sustain, not only the vital principle of animals, but of all the organized bodies in the universe. There is but one *genus* or generic principle proper to this order, which is the *great physical agent of Nature*; and from it all the species proper to this order have their derivation, and are hence subordinate to it.

GENUS OXIGENE.

Or the Principle of Light.

This sublime fluid occupies the space from the central ray in the spectrum, to the outer confines of the red ray. This

genus consists of three species, distinguished by their properties, or qualities, viz.

Species 1. LIGHT. Primitive Electric Light, or etherial Fire. This species occupies the *green* or central ray of the spectrum in which resides the maximum of *Light*. In this ray it is a pure, uncombined, elementary principle, a light without sensible heat, and has been termed the *illuminating ray*.

Sp. 2. CALORIC, or the Principle of Heat, occupies the *red ray* in which resides the *maximum of heat*; and as it is considered, to be composed of 3 volumes of *Caloric*, united to 1 volume of *Oxigene*, it may be very properly termed a *peroxide of heat*, expressive of its maximum. Combinations of the two generic principles are productive of *two oxides of light*, namely, a *peroxide*, or yellow oxide, and a *protoxide* or orange coloured oxide of light, as seen in the foregoing diagram and table. Combinations of the foregoing *species* constitute

Sp. 3. OXICALORIC, or the Solar Oxidizing Rays, namely, *red, orange and yellow*. These have received the name of the *Calorific rays*.

The species of this genus either singly, or combined and variously modified, have been ascertained to be agents for producing and sustaining the vital principle in nature; and are the active causes of *LIGHT, HEAT, ELECTRICITY, expansion, motion, or action, repulsion*, and one species at least of *attraction*, together with various other phenomena in nature, shortly to be explained.

ORD. II.

Secondary Etherial Fluids.

The fluids of this order, although primary with respect to their origin, are secondary to those of the first order, in consequence of the action of the primary agent upon the entire mass of primordial matters of the creation, causing the separation between the fluids of the two orders by its expansive and repulsive properties; wherefore, the fluids of the present order constitute the antagonist agents to those of the first order, and are checks to the excessive action of its species. There is but one *genus* or generic principle proper to this or-

der, and from it, all the subordinate agents or species are derived.

GENUS NITROGENE.

Or the Principle of Darkness.

This etherial fluid occupies the space from the interior central ray to the exterior of the violet ray and its confines. This genus consists of four species, that are distinguished by the following properties, or qualities, viz.

Species 1. DARKNESS. Primitive Etherial Darkness. This species occupies the outer confine of the *violet ray*, in its primary firmamental principle, uncombined, and constituting the *maximum of darkness*; it is therefore a material substance. In combinations with different proportions and intensities of *oxigene* or the principle of light, their union is productive of various *oxides of darkness*, distinguished as follows:

Sp. 2. FRIGORIC, or the principle of Cold; occupying the *violet ray*, in which has been found, the *polarizing* or *magnetizing* property of the solar beam; and in which also it is presumed the *maximum of cold* exists. Combinations of the two generic principles in different proportions, produce two *oxides of darkness*, namely a *peroxide* or *indigo coloured oxide*, and a *protoxide* or *blue oxide of darkness*.* And combinations of the species, produce still further,

Sp. 3. NITRO-FRIGORIC, or the Solar Deoxidizing Rays, namely, *violet, indigo* and *blue*; and these should be termed the *frigorific rays*.

Sp. 4. MAGNETISM, or the Principle of Polarity; whether this principle is the effect of a single or compound ray, has yet to be determined. (See *Species 1.*) I consider this principle to constitute what is termed *negative electricity*. These species of NITROGENE are qualified to absorb light, and to stifle heat, in the proportions assigned them in the table; and further, by their antagonist action to the species of the first order, cause the secondary motions of all bodies termed their *re-action* or resistance, and which are evidenced in the centri-

* In HENRY'S Chemistry by Professor HARE, vol. 1, p. 204, it is admitted, that certain facts in chemistry cannot be explained, except on the supposition that *nitrogen* is an oxide.

fugal forces of all the bodies in the universe. The species of this genus, singly or combined and variously modified, have been ascertained to be among the agents for producing in a subordinate or secondary degree, the vital principle of nature. And their chemical effects are in most instances in an order directly reverse to those of the species of the first order. Hence, *darkness, cold, moisture, re-action, gravitation, magnetism or polarity, contraction, congelation, cohesion, &c.* are the properties and qualities of this genus and its species.

CLASS II.

Ponderable Aerial Fluids or Gases.

This class consists of those *gaseous products*, that were evolved or liberated, during the subsequent processes of the Creation; that is, after the separation of the ethereal matters of the firmament from the more ponderable or material. They are hence less elastic, and less active, do not possess the same degree of subtilty, tenuity, velocity and extreme penetrability, which pre-eminently characterize the species of the first class; add to which, these gases differ from the radiant, imponderable ethereal fluids of the firmament, which are of too subtle a nature to be submitted to the usual mode of examination; "they cannot be confined in any of the vessels we possess; they cannot, therefore, be exhibited in a separate state," (except when combined, as in the solar beam, which we have seen is capable of decomposition.) "Wherefore, their existence and presence are only known and identified from certain phenomena, which go to establish their characters as acting upon our senses, or as producing changes in the more gross forms of matter, which are tangible and ponderable, and therefore easily susceptible of accurate examination." The fluids of this class are susceptible of this examination, not being firmamental and imponderable, but *atmospherical* and ponderable. They are divided into three orders, according to their derivations and combinations, namely,

ORD. I.

This order consists of those ærial fluids or gases, that have their derivation from the species of the first order of the first

class OXIGENE. This order consists of but one species, namely,

Sp. OXIGEN, or *the Base of Vital Air*. The properties and qualities of this species are elasticity, vitality, universal tendency to infuse itself into all bodies; supports combustion, is a constituent in atmospheric air; in the metallic oxides, in many acids, in alkalies and some earths. It is also the *acidifying* and *oxidizing principle* in nature, and the antagonist agent to *nitrogen*.

ORD. II.

This order consists of those ærial fluids or gases that have their derivation from the species of the second order of the first class NITROGENE, the generic source of the following species:

Sp. NITROGEN, or *the Principle of Alkalinity*, by some authors termed *Alkaligen*. The properties and qualities of this species are, elasticity and mortality; being privative of life, incombustible, does not support flame, and is possessed of properties the reverse of the species of the first order. It is a constituent in atmospheric air, in all alkalies, in some acids and earth.

ORD. III.

This order consists of the *ærial fluids* or gases, that are produced by combinations of one or both the foregoing species with other substances, and thus constitute the following compounds:

- | | | |
|-------------------------|--|----------------------|
| Sp. 1. ATMOSPHERIC AIR, | | Sp. 4. Nitric Oxide, |
| 2. Nitrous Acid Gas, | | 5. Nitrous Oxide, |
| 3. Nitric Acid Gas, | | 6. Ammoniacal Gas. |

Lastly. Combinations of the fluids of the two foregoing classes, in different proportions and intensities as agents, by their action and influence upon the ponderable matters of the Creation, have been, and are productive of all the classes, orders, genera, species and varieties of fluid, liquid, and solid bodies in the universe.

In my Medical and Philosophical Essays, published in this city in the year 1819, it will be seen that I contended for the identity of light, heat, electricity and magnetism. (*See those Essays, pp. 182 and sequel.*) Just as this work was going to

press, the London "Mechanics Magazine for August 1825," was put into my hands, and I read with much satisfaction, pp. 246, a very ingenious and learned paper on the same subject, by a writer under the signature of H. C. JENNINGS; and as a proof of the extraordinary fact, that two individuals, in distant countries, shall arrive at the same, or nearly the same conclusions, on the same subjects, I cannot avoid copying the tabular view of the analogies drawn up by that learned writer, in which, as it regards the theory of light and the influence of magnetism on crystallization, it will be seen, that we were both engaged in prosecuting the same ideas, and of arriving at nearly the same conclusions.

JENNINGS' TABULAR VIEW OF ANALOGIES.

<i>Light.</i>	<i>Caloric, or Heat.</i>	<i>Electricity.</i>	<i>Magnetism.</i>
Emanates from the sun.	Ditto.	Probably.	{ Violet ray of light produces.
Travels with great velocity.	Ditto.	Ditto.	Ditto.
Penetrates certain hard bodies.	Ditto.	Ditto.	Ditto.
Imponderable.	Ditto.	Ditto.	Ditto.
Produced by friction.	Ditto.	Ditto.	Ditto.
Transmitted in straight lines.	Ditto.	Ditto.	Ditto.
Produced by percussion.	Ditto.	Ditto.	Ditto.
Produced by condensation.	Ditto.	Ditto.	{ Force can be compounded.
An inconfineable body.	Ditto.	Ditto.	{ Becomes fixed in a few substances.
An agent in chemical decomposition.	Ditto.	Ditto.	{ Chemical decomposition destroys.
Becomes fixed in a latent state.	Ditto.	Ditto.	Perhaps latent in iron.
Most intense when accumulated into a focus or point.	Ditto.	{ Acts most powerfully on conducting points.	{ Ditto.
Produced by decomposition of vegetable and animal bodies.	Ditto.	Ditto.	
Combines with bodies in certain proportions.	Ditto.	Ditto.	Ditto.
Produced by Caloric.	Produces light.	Ditto.	Caloric destroys.
Produced by Electricity.	Ditto.	Produces caloric.	Do. i.e. Electr'y destroys.
Convertible into Caloric.			
Convertible into Magnetism, at least the violet ray.	Ditto.	Ditto.	Ditto.
Transmitted by numerous solid and fluid bodies.	Ditto.	{ Conducted by some solids and fluids.	{ Pervades every known substance, pure iron excepted.

Jennings' Tabular View of Analogies—continued.

<i>Light.</i>	<i>Caloric or Heat.</i>	<i>Electricity.</i>	<i>Magnetism.</i>
Capable of reflection.	Ditto.	Ditto.	{ No substance yet known reflects back the magnetic fluid. Iron absorbs it.
Capable of refraction.	{ Capable of radiation.		
Reflected by metals.	Ditto.	{ Conducted by metals.	
Capable of polarity.		Ditto.	Ditto.
Decomposes certain bodies, <i>per se.</i>	Ditto.	Ditto.	Ditto.
Produces prismatic colours.			
Produces vision.	Assists vision.	{ Assists part vision.	{ Known only by its effects on other bodies, and is unseen.
Capable of insolation.	By ice.	Ditto.	Ditto by pure iron only.
Known in an active and latent state.	Ditto.	Ditto.	Ditto.
Cause of Colours.	Ditto.	Ditto.	Ditto.
Cause of upright growth in plants.		{ Connected with animal vitality.	
Acts in vacuo.	Ditto.	Ditto.	Ditto.
Produces motion.	Ditto.	Ditto.	Ditto.
Excites only one sense, viz. the eye.	Excites feeling and sight.	{ May be seen, heard, felt, tasted and smelt.	{ Does not affect any of the senses, and only known by its effects.
Cause of vision, colours, perfumes, &c.	{ Cause of fluidity, decomposition, evaporation, divisibility of matter, &c.	Cause of lighting, vegetable and animal vitality, &c.	{ Cause of attraction and repulsion, polarity, crystallization, &c.

"I do not pretend," says the author, "to have given all the analogies of light, &c.; but here are quite enough to warrant the idea of identity; and I do not think it impossible to prove, that all the phenomena of nature are absolutely governed and directed by light acting in its various capacity of heat, electricity and magnetism." The foregoing sentiments are certainly very similar to those that I have long since advanced, and which have been delivered in my lectures in 1821, and which are now more fully illustrated in the present work.

X.

Reasons assigned for the adoption of the present Theory.

From the slow and gradual developement of the various phenomena, connected with the processes of electro-medical

practice for many years; and by comparisons drawn from the like phenomena in the atmosphere and on the earth, obviously the effect of this etherial agent, and impelled by the growing importance of this science, from a conviction of its future influence as the basis of all the subordinate branches of Natural Philosophy, of Chemistry, and of Medicine; I have continued to pursue the chain of investigations called for by these phenomena, and having satisfactorily traced them to their sources, the fluids which I have distinguished as the *two great primary agents of nature*, I conceived the propriety of attempting to rescue these agents, the first, from the improper term attached to it, as derived from a simple lump of bitumen, (*electrum*, the Greek term for amber) whence this sublime fluid received the name of the electric fluid. And the last, from the oblivion to which it had been consigned, by the common consent of previous writers, with the exception of *Professor O'GALLAGHER*, and to whose splendid talents, deep research, and profound reasoning, I acknowledge myself to be greatly indebted, for the conviction and consequent establishment of my belief in the truth of the materiality and powerful agency of the etherial matters of *darkness* and *cold*.

To the first agent, which has been traced to the *electric fluid*, I have long since applied the term *OXIGENE* as expressive of its vital influence, being the generic source of *oxygen*, or the base of vital air; and because it is a constituent of solar light, and predominant in the oxidizing rays. With regard to the etherial principle of *darkness*, as constituting the antagonist agent to the preceding, I have applied the term *NITROGENE*, the generic source of *nitrogen*. The reasons for the adoption of this term will develope themselves in the progress of these sections.

It is seen, that I have transferred the *etherial fire*, or electric fluid, from the scale it formerly occupied in the classification of imponderable bodies, to the highest place assigned to these substances; and that I have assumed for it a new name in their nomenclature, and to insure the acceptance of these changes with the liberal and scientific, I will advert to some of the leading phenomena, in nature and in art, in which the influence of this primary agent, this "soul of the universe," is too conspicuous to be denied.

1. The immortal FRANKLIN has identified it with the *lightning of heaven*.

2. It has been proved to exist in most, if not all the bodies in the universe. In the sun and stars, in the atmosphere, in the earth and in the sea.

3. It has been proved to be the cause of *motion, attraction and repulsion*.

4. It is productive of most, if not all the awfully grand and sublime phenomena of nature, in the atmosphere and in the earth; the lightning and thunder, the *aurora borealis* and *australis*, and other corruscations of light in the firmament. On earth it is the vivifying influence of all organized bodies; and in its bowels, is frequently, if not invariably, the primary cause of volcanic eruptions, pseudo-volcanic explosions and earthquakes.

If any individual can, with propriety, select a physical agent in nature, capable of exerting so powerful and so universal an influence on all the bodies of the universe, as it has been clearly demonstrated, that this primary agent does, I shall relinquish the high claims which I have urged for it, and be thereafter content to let it remain in the unmerited obscurity to which the generality of authors appear hitherto to have consigned it. But, as I am well convinced, that it is altogether impossible to deprive it of the rank to which I have elevated it in the scale of science, without doing violence to truth, I shall proceed with the remaining subjects, satisfied with the general acceptance, the foregoing reasons will find with the liberal advocates of science.

XI.

On the Prismatic Colours of Solar Light.

Light is not decomposed until it enters into our atmosphere; where, entering into, or passing through a heterogeneous mass of fluids, it becomes as it were decomposed, and capable of exhibiting its prismatic colours, whose influences are exerted in the lower strata of our atmosphere, and on the earth's surface, in the manner which I have attempted to explain by Diagram No. 3. Attempts to decompose light in the higher regions of the air, have proved, that at an elevation of $1\frac{1}{2}$ miles, the prismatic colours were feintly per-

ceptible; and from the very nature of this fluid, I am convinced, that in still higher elevations, it could not be at all decomposed, but would exhibit its primitive colour, that of a pure silvery white. Experiments of this kind, however, should not be made on mountains, or other elevations influenced by the reflecting and refracting rays of light—but in the open atmosphere in balloons.

SIR ISAAC NEWTON succeeded in decomposing the solar light into seven prismatic rays in the order noticed in the diagram No. 1. By referring to "Proposition 3d, page 9," that "material effects must arise from material causes," it is evident, that these colours are derived from some positive quality or cause, acting with or against the primitive light; and this may be considered as arising from the action and influence of the antagonist agent upon that portion of solar light, which is formed by the union of *OXIGENE* and *caloric*, hence termed *oxicaloric*; and by which influence the ethereal matters of darkness are in some way blended with those of light; which combinations result in various *oxides*, already particularized in the scheme for this classification.

That each distinct colour possesses distinct and opposing qualities, as far as chemists have advanced in their experiments, has been satisfactorily proved; and are universally admitted to be *facts*, as clearly established as any of the philosophical facts have been; and this warrants the conclusion, that each distinct colour possesses distinct properties, and must consequently be composed of as many distinct proportions of darkness and light, or *heat* and *light*, as there are colours represented on the spectrum.

The primary colours of light appear to mark the absorption of *caloric* in proportion to their refrangibility. Such has been the conclusion of the celebrated DR. HERSCHELL, and various other scientific experimenters, who have established the fact, that the prismatic rays possess different temperatures, and have different capacities for absorbing heat. From numerous experiments made on the prismatic rays, it has been proved, that "the *red ray* being the least refrangible, indicated to a very sensible thermometer the greatest degree of heat; next in the *green ray*, and so on in a diminishing progression to the violet ray, which has the greatest refrangibility," and

in this ray the thermometer is scarce affected. But, while the *red ray* indicates the greatest degree of heat, it is far from evidencing much illuminating power, the central, or *yellow* and *green rays*, illuminating objects more perfectly.

It has consequently been decided, that the *maximum* of heat is confined to the *red ray*, and just without its confines; and the *maximum of light*, or of illumination, lies in the brightest yellow or palest green. But beyond the confines of the spectrum on the one side, that is a little beyond the *violet ray*, where the thermometer is not affected, it is remarkable that in this place there are also invisible rays of a different kind, which exert all the chemical effects of the rays of light; and with even greater energy, by *deoxidizing* bodies more speedily than the *red* or any intermediate colour. From these circumstances, it has been proved, that the solar beam consists of rays of three distinct qualities. Of those that excite heat, and promote *oxidation*, hence termed *calorific rays*;* of illuminating rays, exciting and promoting *vision*, hence termed *illuminating rays*; and of *deoxidizing* or *hydrogenating rays*, by some termed *colorific rays*. "A striking illustration of the different power of the various kinds of rays, is furnished by their effect on phosphorous. In the rays beyond the red extremity, phosphorous is heated, smokes, and emits white fumes; but these are presently suppressed on exposing it to the *deoxidizing* rays, which lie beyond the violet extremity." (See HENRY, vol. 1. p. 109, where several experiments with *chlorine* have been made by SIR H. DAVY, with these rays perfectly agreeing with the above.) (THOMSON, ACCUM, HENRY, BRANDE, &c. Chemistry.)

By attending to the seven prismatic colours as laid down in the diagram, they are found to distinguish very clearly the presence and influence of the two primary agents of nature, OXIGENE and NITROGENE; and by a critical analysis of the preceding remarks, extracted from the works of the most eminent practical chemists, we may be enabled to detect and thence to explain the actual qualities of darkness, cold, light, (or electricity,) heat, vision, colours and magnetism, as seven properties of the seven rays of solar light.

* See Species of Darkness, p. 21. I would add, *frigorific rays* exciting cold.

XII.

Of the properties and qualities of the Prismatic Rays.

On tracing the rays, in Diagram 1st, from the *green*, which is the central ray, onwards to the *red*, we discover in this division the *maximum of light and heat*. On reversing the order, and now tracing the rays from the *green* onwards to the *violet ray*, and beyond its confines, the heating power is so much absorbed or diminished, as not to affect the thermometer. According to the rules of genuine philosophy, these phenomena can be accounted for upon no other principle, than that of admitting the action and influence of an opposite power, to that of light and heat existing in the solar beam. For, it will be unphilosophic to say, that the principle of light and heat in the solar beam, produces contrary effects, (*See Axiom 7, p. 8,*) as it has been proved, that "light and heat are qualities of the same substance."

By admitting into the solar beam the etherial principle of darkness, as the antagonist agent to light, we are then enabled at once to account for both the cause and effect of these phenomena; and shall at the same time perceive the supreme wisdom of the CREATOR, in thus establishing checks upon these primary agents, by whose antagonist actions the revolutions of days and nights and seasons are governed. It is hence obvious, that by the absorbing quality of NITROGENE and its species, the excess of light and heat are progressively diminished from the *red ray* to the *violet*, i. e. the *frigorific* rays, where I have fixed the *maximum of cold*. On the other hand, by the expansive and repulsive property of *caloric*, the degree of cold is also progressively graduated and modified from the *violet ray* to the *red*, i. e. the *calorific* rays, in which chemists have placed the *maximum of heat*. In the green or central ray, which has been determined to be the *maximum of light*, OXIGENE, or the primitive uncombined electric light, sits enthroned as the umpire, between the antagonist influences of *heat* and *cold*.

To draw, therefore, a fair and rational conclusion from the foregoing well established phenomena, it will result, that the rays are actually coloured by various proportions of the black matters of NITROGENE, or the principle of darkness, as laid

down in the tabular arrangement, or graduated scale of supposed combinations, (*page 19:*) and that they hence possess the following distinct and specific qualities:

1. From the outer confine of the central or green ray in the spectrum, to that of the *red ray*, the principles of LIGHT and HEAT are concentrated by the combination of a given proportion of OXIGENE to another given proportion of *caloric*, and thus constituting *oxides of light*, oxidizing bodies submitted to these rays, particularly the red, in which the *maximum of heat* is found.

2. From the opposite outer confine of the *green*, to that of the *violet ray* and its confines, the principles of DARKNESS and COLD are concentrated by the combination of a given proportion of OXIGENE to another given proportion of NITROGEN, and thus constituting *oxides of darkness*, possessing the property of *deoxidizing* or *hydrogenating* the *oxides* of the former rays.

Chemists have determined, that *oxygen*, or the life exciting portion of the atmosphere, is an oxide of some body, rendered fluid or gaseous by a large proportion of *caloric*, and this body they say is *light*. Further, it has been acknowledged, that it has never yet been obtained in a complete state of separation; that "in the most simple form under which we can procure it, it is combined with *caloric*, and probably with *light* and *electricity*, constituting *oxygen gas*." (HENRY.) I am therefore warranted in considering each distinct ray as a distinct oxide, either of darkness or of light, whence I have concluded, that

3. Combinations of the red, orange and yellow rays, with a proportion of the green or central ray, are the *solar oxidizing rays*; and being composed of OXIGENE and *caloric*, I have thence, termed these rays *oxicaloric*, in which *light*, or positive uncombined *electricity* and heat resides.

4. Combinations of the *violet*, *indigo* and *blue rays*, with a proportion of the green or central ray, I have termed *nitro-frigorific*, as they are compounds of NITROGEN and OXIGEN; in which division the principles of darkness, cold and magnetism, or negative electricity, resides.

5. Combinations of the *indigo* and *blue rays*, with a proportion of the *green*, produce *nitrogen*, a constituent in at-

mospheric air, and, doubtless also in all solid bodies, in some liquids, and in many fluids yet to be ascertained. I consider it to be present in all opaque minerals.

In the foregoing arrangement, we can clearly conceive the material agents or causes of all the phenomena of nature, without referring them to ideal or imaginary powers; or of carelessly determining them to be nothing positive or material. The whole combined causes of these phenomena, may be found, in some measure, united, and accompanying each other in the fluids, emanating from the firmament to the sun, and again from the sun to all the bodies in his system, as so many checks one against the other. The first generating heat and oxidizing bodies; the other, generating cold and de-oxidizing the oxides of the first. Nay further, we discover in the *violet ray* the property of magnetism in the polarising influence of *nitro frigoric*; while on the other hand, we discover in the *red ray* the property of depolarising the magnetism of the former by the influence of the heat of *oxicaloric*, the antagonist power of *nitro frigoric*; and in the green ray we discern, the ethereal light or positive uncombined electricity. These facts have been well established by the experiments, first of *Professor MORRICHINI* of Rome, and subsequently by *DR. BREWSTER*, *M. ARAGO*, *M. BIOT* and others; and magnets are now artificially prepared, by means of a *condensing lens* with the *violet ray* of the prism thrown upon them, whose polarity has been pronounced equal to those prepared by the magnet or loadstone. The *MARQUIS RIDOLSI* has also repeated the same experiment with success, having powerfully magnetized two needles, the one in thirty, and the other in forty-six minutes. *DR. FRANKLIN*, by his electrical battery, gave polarity to needles, and reversed it at his pleasure. It has been also proved, that metals, particularly *iron* and *steel*, and according to the *ABBE HAUY*, several other minerals, possess magnetic properties. The two former, when struck with lightning, have been found to have a powerful magnetic attraction for some time thereafter. There is also, in all probability, certain properties or qualities in each of the rays, that act as agents upon the animal economy, influencing and exciting externally the senses of touch, taste, smell, vision, hearing and motion, which is the primary prin-

ciple of all the senses. Internally, of memory, imagination, conscience, the passions and emotions of the mind and reason. I confess that I am not qualified for the task of defining, in any positive terms, the precise action of these rays upon our senses. I can only reason on them from analogy; and hence, as the central or green ray has been designated as the *maximum of light*, I have considered that ray as the agent of vision, as marked in the first figure of the diagram.

A predominant influence of the dark rays, may probably produce *magnetic excitement* in the animal fibres; while that of the light rays may produce an *electrical excitement*. The former of which conditions may be considered as equivalent to the systems being *negatively electrified*; and the latter to that of its being *positively electrified*; and these states tend to excite the various senses, both internal and external. May not this, in some measure, serve to account for those extraordinary dispositions in some constitutions; and to which they are not commonly, but casually subject; particularly the dispositions to melancholy, grief, dejection, &c.? And may not those nervous affections, the *maladies imaginaires* of the French writers, owe their origin to the influence of one or other of these agents? These questions, it is confidently believed, are neither improbable nor unphilosophic; but are consistent with the theory of the nerves, advanced by those learned and indefatigable anatomists and physiologists, CHARLES BELL, jun. and M. MAGENDIE.

The limits assigned to these sketches, will not admit of an enlarged view of this subject, such as has been taken of it in my Elements of Electricity. The hint is given, however, in this place, with the view of exciting further inquiry on this important suggestion.

• XIII.

Remarks on the Prismatic Colours of Light.

Numerous experiments with OXYGENE, or the etherial electric light, have resulted in its being found a perfectly pure brilliant fluid, possessing, as far as experiments have been carried, all the essential properties of light, as defined by philosophers; who have, however, had no reference to this sublime fluid in their remarks. "I think," says DR. FRANK-

LIN, in his *Letters on Philosophical Subjects*, edition 1769, p. 265, "the electric fluid is always the same; yet I find, that weaker and stronger sparks differ in apparent colour, some white, blue, purple, red; the strongest white, the weakest red." These appearances I have witnessed ten thousand times, or more, and can account for the appearance of these colours, from the existing states of the air, through which the sparks pass; and have actually ascertained, that the electric fluid, when pure, is of the colour of the planet *Venus*, when at her greatest elongation; and that the colours abovementioned depend upon the medium through which the sparks have to pass, as also upon the qualities of the conducting bodies by which they are transmitted.

On comparing the experiments made by DE GROTTUS on the colour of the electric spark, when transmitted through different gases; with my own observations with different metallic conductors, and atmospheres of different densities, it will be proved, that the electric light is highly brilliant, and without colour.

De Grotthus' Experiments.

1. In atmospheric Air of double density, brilliant, but not coloured. }
2. In Hydrogen gas—purple.
3. In Phosphuretted hydrogen—red.
4. In Ammonia—red.
5. In Dry Carbonic acid gas—violet. }
6. In Oxygen gas—violet. }
7. In Aqueous vapour—orange.
8. In vapour of ether—celadon green. }
9. In vapour of alcohol—ditto. }

My own Observations.

1. Dry Air. Same.
2. Gold—bluish white, pale purple.
3. { A moist atmosphere gives always
4. { a red or orange coloured spark.
5. { Copper with rough edges gives
6. { a violet colour in the dark.
7. Ditto.
8. Ditto, so also the skin.
9. Presented to a brass knob.
10. Iron and steel, silver white.

It is no improper idea to suppose, that the *acid* and *alkaline* principles, in the rays, as marked in the diagram No. 1, influence the colours, the *alkaline* turning the blue to green, and the acid changing them to red, &c.

It is thus proved, that the colour of the electric fluid in a pure and dry air, is a perfect planished silver-white. *Caloric*, as seen in the solar beam, is a *gold or fiery red*. Combinations of these colours, in different proportions and intensities.

result in a *yellow coloured peroxide*, and an *orange-coloured protoxide* of light. But it requires the agency of some other body to supply the remaining colours of the spectrum. The etherial matter of darkness, NITROGENE, in all probability a perfectly black or *carbonous oxide*, in combination with different proportions and intensities of light, will yield, first, a *violet coloured oxide*; secondly, an indigo coloured; and thirdly, a blue coloured oxide of darkness. OXIGENE, which occupies the central ray, in itself perfectly white and transparent, is tinged, as it were, by the yellow oxide on one side, and the blue oxide on its opposite; hence, from the admixture of these shades, it assumes a green colour, and thus all the colours of the spectrum are completed. No person acquainted with the mixture of colours, will hesitate a moment in admitting this to be a fact, resulting invariably from an admixture of colours in the order above mentioned.

XIV.

Remarks on the Principle of Heat.

I have nothing new to add to this principle, except that of having classed it among the imponderable bodies as a species of OXIGENE, for the reasons assigned. (Paragraph 6, p. 13.) As the principle of heat in the solar beam, *caloric* is considered as occupying the *red ray* entire, as also the invisible rays beyond its confines—and that it enters into combination with the principle of light in the *orange* and *yellow rays*. The principle of heat is considered latent and passive in the solar rays, until it approaches towards the lower stratum of our atmosphere, where its action is excited by the heterogenous mass of matters emanating from the earth. Its influence is not felt in very high elevations. *Aeronauts* describe the cold to be intolerable at an elevation of 2600 *toises*, French, or 15,316 feet. The active principle of heat is therefore confined to the lower stratum of our atmosphere, and in the earth. By the term *caloric*, is meant that principle or quality in the agent for producing heat. It is therefore the cause of heat, in whatever way it may be excited, whether by means of actual fire, by *attrition*, or the rubbing two dry pieces of wood together, or by the combination of fluid, liquid or solid substances, whose union are productive of heat, such as mix-

ing water with sulphuric acid, &c. In the same way, the term electricity has been applied to that fluid, which is elicited by various processes, such as friction, metallic fermentation, &c.

"*Caloric*, so far as its chemical agencies are concerned, may be chiefly considered under two views—as an antagonist to the cohesive attraction of bodies—and as concurring with, and increasing elasticity. By removing the particles of any solid to a greater distance from each other, their cohesive attraction is diminished; and one of the principal impediments to their union with other bodies is overcome. On the other hand, caloric may be infused into bodies in such quantity, as not only to overcome cohesion, but to place their particles beyond the sphere of chemical affinity. Thus, in the class of substances called *gases*, the ponderable ingredient, whether solid or liquid, is dissolved in so much caloric, that in mechanical properties the gases agree with the air of our atmosphere, especially in being permanently elastic. Different bodies of this class do not, in general, unite by simple mixture: But if, of two gases, we employ either one or both in a state of great condensation, or compress their particles nearer to each other by any means, the gravitating matter of both unites and forms a new compound. Thus, *hydrogen* and *oxygen gases* remain together in a state of mixture for any length of time, without combining; but if we force their particles into a state of contiguity, by sudden and violent mechanical pressure, they unite and compose *water*." (HENRY.)

From the foregoing definition of the chemical and mechanical properties of caloric, it is proved to be the agent of *expansion* and *repulsion*; whence it is but reasonable to suppose, that nature is supplied with an antagonist agent qualified to counteract the influence and effects of this agent; and as the principle of *cold* is most certainly opposed to that of *heat*, I have assumed that principle as the antagonist to *caloric*, and have accepted the term *frigoric*, as applied to it by DR. WILLIAM WHITRIDGE of Rhode-Island.

The expansive property of caloric is different in different bodies; that is, it is exerted or extended in proportion to the opposing agent; but these peculiarities belong to its chemical

action on bodies; and hence, are to be seen at large in all elementary works on chemistry. Like electricity, an important property of *free caloric*, the knowledge of which has been acquired by means of the thermometer, is its tendency to an *equilibrium*, and this appears to be an established property among all the agents of nature. Those effects of *caloric*, in the production of which it loses its distinguishing properties, may be classed under two general heads.

1. All bodies, in passing from a denser to a rarer state, absorb caloric. Thus solids, during liquefaction, imbibe a quantity of caloric, which ceases to be apparent to our senses, or to the thermometer; or, as it has been termed, becomes *latent*. In a similar manner, solids and liquids, during their conversion into vapours, or *gases*, render latent a quantity of caloric, which is essential to the elasticity of the new product. In common language, says DR. HENRY, cold is, in such cases, said to be produced; but by the production of cold, we are to understand in philosophical language, nothing more than the passage of caloric from a free to a latent form.

This may be termed the language of Philosophy, and has indeed every appearance of correctness, until we enter more fully into the properties of each agent respectively. Now the truth is precisely this: Most philosophers seem to have come to the conclusion, that there is no such quality in nature as positive cold; that the term means nothing more than the absence of heat, or of the sensation of heat; or, as it has been expressed above, when *caloric* or heat ceases to be apparent to our senses, or to the thermometer, it is said to be latent. Now, all this is certainly very rational, applied to caloric as an agent, which, it is admitted, is capable of existing in either its latent or active state; but I am not disposed to make this concession, to the total exclusion of the idea of its antagonist agent *frigor*. But of this, more will be said in the section on cold.

2. "All bodies, by an increase of density, evolve or give out caloric which passes from a latent to a free state." This phenomenon is easily comprehended by the fact, that caloric is latent in the higher regions of our atmosphere; but in those regions in which it is more condensed towards the lower strata, this principle is evolved; or in other words, it passes from

a latent to a free or active state, by which heat becomes apparent to our senses, and is indicated by the thermometer. According to the experiments of M. HUMBOLDT, the extreme heat of the air no where exceeds 140 deg. *Fahrenheit*, and this only within three feet of the ground.

The effects of free caloric are, 1st. That it expands all bodies. 2. That it is the cause of fluidity. 3. Of Vapour. Besides these effects, it possesses the property of *radiating* or finding its way through space independently of other matter, and with immeasurable velocity. In this state it has been called radiant heat, or radiant caloric. It passes also, but more slowly through solid and liquid bodies, which are then termed conductors of caloric. Radiant caloric possesses also those properties of light termed reflection and refraction; and is absorbed with different facility by different substances, as proved by DR. FRANKLIN'S experiment with different coloured cloths; by which it was found, that dark coloured cloths absorb more heat than cloths of light colours; and *Professor O'GALLAGHER* considers the ethereal matter of darkness to be the great absorbent of heat and light. Caloric or heat must have its antagonist, and this antagonist I shall shortly prove to be that body in nature to which has been applied the term frigidic.

As early as the year 1758, GOVERNOR ELLIS observed, that the human body was capable of generating cold; and DR. CULLEN suggested many arguments to show, that living animals possessed a power of generating heat, independently of any common chemical or mechanical means, either of fermentation or friction; and also of generating cold, or of destroying heat when the heat of the atmosphere exceeded the proper temperature of their bodies. (*Amer. Med. Lexicon.*) This certainly proves, that the animal economy is also possessed of those qualities which enables it to accommodate itself to the temperature of the atmosphere; and that it is, by a law of nature, capable of exciting either of the principles of heat or cold to a certain degree, but not beyond it. This quality in the animal economy of generating cold, appears to be, from the experiments of DRs. FORDYCE, SOLANDER, and MR. BANKS, equal if not beyond the excess of heat. For "DR. SOLANDER stood in a room heated to 210 deg. for three

minutes, during which time the quicksilver in the thermometer sunk to 196 deg.; and MR. BANKS remained seven minutes in the heat of 211 deg.; in which time the quicksilver had sunk to 198 deg. The heat of their bodies, in these experiments, rose very little above its usual state."

The usual heat of healthy persons is not above 97 deg. *Fahrenheit*. In ardent fevers it rises to 112 deg. In the year 1824 the heat of the weather was 116 deg. in the open air at my residence on the green; in the city it was much greater, and in some instances proved fatal to several persons. In general, however, the citizens were healthy until the rainy season set in; all which circumstances go to prove, that the animal economy is capable of accommodating itself to a heat considerably above that of its standard temperature; and that it possesses the property of counteracting a heat more than double that of its own standard. It is to be remarked, however, that these experiments relate to dry heat alone. The following have been made with moist heat or vapour.

I remained for the space of 40 minutes in the pavilion of a vapour bath, in which the mercury rose to 120 deg. and found that my sensations were agreeable and pleasant, with the exception of the first four or five minutes; during which, a stricture or tightness of the chest, with a sense of suffocation was felt. This was produced, no doubt, at the period when the peculiar energy of the animal economy was engaged in accommodating itself to the increased temperature; but the moment when re-action succeeded, a most profuse perspiration, accompanied with very pleasant feelings for the remaining 35 minutes, were experienced. As a proof that the effect of re-action was from the centre to the circumference, the perspiration was strongly impregnated with the *muriate of soda*, tasting as strong as salt brine. DR. M. HOLBROOK, who superintends the Medicated Vapour Bath in Chalmers-street, assures me that he has remained in the pavilion for 20 minutes in a heat of 140 deg. without the smallest inconvenience. These facts prove, that the animal economy accommodates itself with ease to an increased dry temperature, many degrees above its own standard; and that it also endures, without inconvenience, an increased moist temperature of from 20 to 40 deg. above blood heat.

Remarks on the Principle of Darkness.

In our investigations of the substances of *light* and *heat*, we have had the aid and assistance of naturalists and experimentalists of all ages. But in this, with the exception of DR. O'GALLAGHER of Dublin, in his "First Principles of Nature," we have no authority beyond the Bible, from which to form any thing like a conclusion, that the substances which are the subjects of the present and following section, have ever been recognized by philosophers as parts of the works of Creation. On the contrary, they have been rather treated as negative substances; bodies that were merely ideal or imaginary, and asserted to be nothing positive, though we read, *Isaiah*, ch. xlv. v. 7, "I form the light and create darkness."

"As enlightened philosophers have discovered that *heat* and *light* are two qualities of the same substance, so we are now authorised to think that *cold* and *darkness* are also qualities of the same substance, of a nature opposite to that of the sun and stars. For, as cold is a quality inimical to and destructive of heat, a quality both positive and powerful, so certainly, it must have some real positive substance to support it."* As it would by far exceed the limits assigned to this work, to give a detailed account of the views and arguments of this learned author on this important subject, I must refer the reader to his invaluable volumes, and content myself with giving an abridged sketch of his reasonings and conclusions, which are to the following purpose:

In the course of these arguments it has been, in some degree, proved from reason and analogy, that *cold* and *darkness* must have their material substances—that they are real and positive qualities—and to suppose a quality without a supporting substance, is a contradiction in idea, because the instant a quality is mentioned, the mind turns on itself and enquires, what it is a quality of; which operation of the mind is, either an innate principle of reason, or a judgment founded on common experience; either of which motives is an authority for the justness and propriety of the question, and a proof of

* O'Gallagher's First Principles, vol. 2, p. 131.

the axiom it supposes; to wit, that all qualities have their supporting substances. This question can only be answered in the affirmative reply; for it is impossible to conceive how *something*, which must necessarily be supported by and depend upon *something*, can subsist on, and be supported by *nothing*. Cold, therefore, and darkness, must be supported by some kind of substance or substances. Every agent in nature, capable of affecting bodies, causing sensations, and producing sensible, material effects, as we have heretofore observed, (Proposition 3, p. 9,) must be material.

Darkness is, unquestionably, an opaque or black substance, having the property of absorbing and stifling light; and this absorbent of light must exist in air, earth and water; in short, in all bodies, the luminous excepted; and this, because the principle of light has overcome or predominates over the principle of darkness. That there should be a quality or colour, without a supporting substance, is not only unphilosophical, but even ridiculous to imagine; but to suppose and to assert, (as the advocates of the doctrine, that "cold is nothing positive," do) that an imaginary quality should devour or consume matter, is the quintessence of absurdity. On the contrary, that matter should envelope, absorb, and consume matter, is as natural, as that matter should beget or produce matter, both are evident from the transformation of bodies, and consonant to the works of nature. For, generations constantly arise from corruptions, and the birth of one thing from the dissolution of another, as we see in the seed and its produce, the tallow and its light, and other similar transformations. Fire causes the evaporation of water, and drought absorbs moisture; but it is not the qualities *hot* and *dry* which absorb the qualities *wet* and *moist*; but the substance, *hot* or *dry*, that envelopes and absorbs the body *wet* or *moist*, for it is body or substance, and not quality, that has dimensions or capacity to incorporate. So also it is a black substance or matter which absorbs light, and not a simple quality or colour, which, without a supporting substance, can have no capacity to envelope it.

The opaque matter or substance of darkness, separated from light at the Creation, is, nevertheless, an ingredient in the ethereal fluids of the firmament, where, according to its

agency and propensities it is co-existent with light, with which it mixes in the same way that its species *nitrogen* mixes with *oxygen*, to constitute atmospheric air. In short, all the radiant imponderable and ethereal fluids of the firmament, and which constitute the *ether* of the ancients, the *etherial medium* of SIR ISAAC NEWTON, the *ELASTIC species* of SIR ROBERT BOYLE, and the *elementary fire* of BOERHAAVE, are infused into the sun by their centrifugal forces, in which orb they become assimilated to his nature, and are elaborated into solar light and heat, (i. e. latent heat) to be again transmitted by the centrifugal force of the sun to all the bodies in his system. And that these ethereal fluids are the supporting substance of the “flame or compacted light of the sun and stars,” and are the colouring principle of his rays, accompanying them in their passage to all the bodies within his system, has, I conceive, been made clearly to appear from the arguments and deductions from them, and upon principles laid down in the axioms and rules in the preceding sections, and illustrated by *Diagram No. 1*. “It appears, from the very accurate observations of SAUSSURE, (*Journal de Physique, March, 1777, &c.*) that the colour of the sky acquires a deeper shade in proportion as it is viewed from a more elevated situation. Consequently, at a certain height, the blue will disappear altogether, and the sky appear *black*; that is to say, it will reflect no light at all.” (ACCUM.) This paragraph unquestionably proves the absorbing and colouring qualities of NITROGENE, or the ethereal firmamental principle of darkness, as far as the actual observations of scientific naturalists have as yet been able to prove facts connected with the imponderable fluids of the Creation; and should be hence admitted in support of the principles contended for in this essay, or at least until they can be disproved.

XVI.

Of Frigoric, or the principle of Cold.

“Cold,” say the philosophers, “is nothing *positive*, but is to be considered rather as the effect of the absence of *heat*, produced by the abstraction or condensation of atmospherical air.” Whatever is the cause of such abstraction or condensation of air, must of course be the effect of a power that is op-

posed to and coercive of heat. Ice has been offered as an example of deficient or latent heat. SHUCKBURG has observed, that whatever may be the height of the barometer, or the elevation above the sea, of the place where the experiment is made, the thermometer, when immersed in liquifying ice or snow, always settles at 32 deg. of *Fahrenheit*. It has hence been determined, that the temperature of snow, or of thawing ice, is uniformly the same at all times, and in all places.

As *caloric* is the cause of the liquefaction of ice, it is obvious, that a given quantity of that fluid must enter that substance during its liquefaction, yet such is the property of *frigorific*, the principle of cold, that notwithstanding the quantity of *caloric* absorbed by ice, during its passage from a solid to a fluid state, the thermometer immersed in the liquid affords precisely the same temperature as when immersed in pounded ice, to wit, 32 deg. *Fahrenheit*. As a proof that the ice must have imbibed *caloric*, during its conversion to water, it is justly observed, that "a colder body can never be in contact with a warmer one, without receiving *caloric* from it; the *caloric*, therefore, which has entered the ice, but is not found in it by the thermometer, is said to have been latent." (HENRY.)

The following experiment will show the quantity of *caloric* that enters a pound of ice, and becomes latent during liquefaction. Heat a pound of water to 172 deg.—add one pound of ice at 32 deg.—then immerse the thermometer into the mixture, when the ice is melted it will indicate no more than 32 deg., a proof that all the excess of *caloric* in the *hot water* has disappeared. From 172 deg. take 32 deg., the remainder 140 deg. shows the quantity of *caloric* that enters a pound of ice during its liquefaction, and is rendered latent by the coercive principle of *frigorific*.

The fact established by this experiment, which may be seen in HENRY'S Elements of Practical Chemistry, is this, that *frigorific*, or the principle of cold, has been proved by demonstration, to absorb five and nearly three-fourths its quantity of *caloric*; and even with this excess of the principle of heat, retains its own temperature! It appears to me, that there can be no fact better established in philosophy, or that can go further to prove an effect of any cause, than this goes to prove the co-

ercise property of *frigoric*; and that it has the property or quality of absorbing heat in the same manner that NITROGENE or the principle of darkness has been shown to absorb light. I shall hereafter show, when treating of the *acids* and *alkalies*, that *nitrogen* influences *oxygen* in the same way, by overcoming the acid principle and constituting alkaline substances.

The abstraction of caloric, and the condensation of atmospheric air, the avowed causes of cold, we thus perceive, is the effect of an agent antagonist to heat, and by which the sphere of action of caloric is contracted, and its capacity for causing expansion is thus weakened; in other words, it becomes latent or passive. We perceive further, that both the agents and their species, exist in either their free or combined states; that the predominance of one agent, necessarily coerces and overcomes, or subdues the other. Hence, hot water of 172 deg. is coerced by the same weight of ice at 32 deg.—and in this experiment the principle of cold is not altered, though it has absorbed an excess of 140 deg. of the principle of heat! How then, in the name of reason and common sense, can learned men so gravely assert, and so tenaciously support, such philosophical sophistry, as not only to deceive themselves, but also to involve their adherents in such palpable errors, with regard to the materiality of the agents of heat and of cold? For, while they insist upon the materiality of one agent, and deny the existence of its antagonist, they are, in fact, endeavouring to prove, that a substanceless non-existing body, is capable of coercing their acknowledged agent *caloric*; or, in plain terms, that *nothing positive* has the power to overcome and subdue *something positive*! That although hot water of 172 deg. was reduced 140 deg. by the addition of an equal weight of ice, *that* a non-existing principle in the ice, occasioned an actually existing principle in the hot water, to take wings and fly away to give place to nothing! Comment on this is unnecessary.

That the principle of cold, as well as that of heat, emanates from the sun, having been previously infused into him by the action of the fluids of the firmament, is another principle contended for in the present theory. I have already observed, (page 12, and again 32,) that the ethereal fluids of the firmament being infused into the sun, afforded nutriment or

fuel to that luminary, in which these principles of darkness and light, heat and cold, &c. were assimilated to his nature, and were elaborated into solar light in the form of a latent or lambent flame; and that these matters are without sensible heat until they enter into our atmosphere; and even then, *cold* continues to predominate until the solar beam approaches near to the surface of the earth, and among the heterogeneous mass of fluids in the lower stratum of the atmosphere; and here entering into a new combination, caloric or the principle of heat, is evolved in the same manner that it is evolved on the admixture of one part sulphuric acid to five parts of water. The Diagram Fig. 3, will explain, not only the expansive and contractive qualities and capacities of each agent, but, at the same time, will afford a correct view of the actual existence of these agents in the firmament, the atmosphere, and the earth. It will be proper, however, to take notice, that although I have represented but a single ray decomposed in the atmosphere, we are to conceive the incessant transmission of myriads of these rays from the sun, to the full supply of our globe; notwithstanding which, they will occupy the circles, and exert the influences peculiar to each of their principles, as described by it within the limits of the atmosphere.

Explanation of the Diagram.

In the Diagram Fig. 3, caloric or the principle of heat, is supposed to occupy the lower stratum of the atmosphere in which it exists in its greatest intensity, represented by 1 or 1 volume. In the orange ray it is expanded to $1\frac{2}{10}$, and in the yellow ray it is still further expanded to $1\frac{3}{10}$ or $1\frac{1}{2}$ volumes.

The maximum of light represented by the green circle, measures $1\frac{7}{10}$ volumes, equal to $1\frac{1}{2}$; while the violet ray occupies $2\frac{1}{2}$ volumes. Hence, the degree of resistance that the principle of cold opposes to caloric, is more than double the proportion of the latter. Thus, by the time that caloric reaches the outer limit of the yellow ray, it is so much expanded as to lose its intensity; and on entering the region of the blue ray, it is entirely absorbed, and is then rendered latent, and may serve to explain the reason, why *Æronauts* find the cold so intolerable at the distance of 2600 French

toises,* or 15,816 feet from the surface of the earth, a proof that caloric becomes latent at a distance little less than three miles, or 5272 yards from the earth's surface. The atmosphere of our globe extends to an unknown height. Some astronomers, in consequence of their observations on eclipses, assert it to extend 2642 miles, or one-third the diameter of the earth. DR. BLAIR observes, that at 45 miles from the earth's surface, it ceases to reflect the rays of the sun's light.

If we admit the reflective portion of the atmosphere to extend to an elevation of 60 miles above the surface of the earth, and suppose it to be occupied by light in the proportions of the decomposed ray, then the *violet* ray, which measures 80 deg. on the spectrum, will occupy 15 miles, or one-fourth of the atmospheric space; the *indigo ray* $7\frac{1}{2}$ miles or $\frac{1}{4}$; the *blue ray* 10 miles or $\frac{1}{6}$; the *green ray* $\frac{1}{6}$; the *yellow ray* somewhat more than $\frac{1}{4}$; the *orange ray* $\frac{1}{16}$; and the *red ray* $\frac{1}{16}$. Hence, the three dark rays united occupy $32\frac{1}{2}$ miles, upwards of one half the atmosphere, while the four light rays occupy only $27\frac{1}{2}$ miles; and if we leave out the *intermediate rays*, and compare the proportions of the *violet* and *red rays*, we find the principle of cold to that of heat as $2\frac{1}{2}$ to 1. Again, the two rays marked *nitrogen*, will be to those representing *oxygen*, nearly as $1\frac{1}{2}$ to 1. (See Diagram 2.)

It is not improbable, that in the changes of seasons from summer to winter, and on all extraordinary and unseasonable transitions of temperature, that the order of the rays may be inverted; and that hence, during cold weather, the dark coloured rays predominate near the earth, while in the hot weather they are repelled from it, &c.

That the principle of cold is abundant, that it is even predominant in the higher regions of the atmosphere, has been ascertained by so many experiments, that they authorize the conclusion, that active heat does not travel to us from the sun, but active cold. And that active heat is confined to the earth and to the lower strata of the atmosphere, is further proved from the circumstance, that *miners* and *colliers* assert, that the deeper they penetrate into the bowels of the earth the warmer they find it. "Cold, then," says DR. O'GALLA-

* See the account of MR. ROBERTSON'S ascent, published in the City Gazette of Charleston, Tuesday, July 19th, 1825.

GHER, "does not originate in the earth, nor in the waters of the sea, or of the land; its liquid and diffusive nature proves, that a great quantity of the etherial and electric matter is blended with it, and is further proved by its conversion to ice when deprived of its etherial fire; and still further, from its great thirst for electricity when thus converted to ice. Cold comes from above, and is not a quality of the air: for the air is composed of its basis, the elastic or electric matter, and the evaporations of the earth and water therein buoyed up."

As it regards the chemical agencies of *frigoric*, it is the antagonist to the expansive property of *caloric*; and the agent for effecting the cohesion and consolidation of bodies, by overcoming the elasticity of matter, and attracting their particles so closely, as to constitute the utmost solidity, to the total seclusion of the influence of free caloric; that is, the solids thus produced, are incapable of decomposition by the usual processes of nature; such, for instance, as the *diamond*, or any of the more perfect crystals of *siliceous* or *aluminous* earths. Certainly, then, an agent possessed of qualities capable of producing such material effects upon the unorganized portions of matter, and of exciting the most powerful sensations in the organized, must be material, and if material, an active and positive substance.

The following remarks on the temperature observed at different places on the earth's surface, are made by the editor of the *Annales de Chimie*, and are extracted from the *Carolina Journal of Medicine, Science and Agriculture*, for July, 1825:

"In no place on the earth's surface, nor at any season, will a thermometer, raised two or three *metres* above the soil, and sheltered from all reverberation, attain the 37th degree of *Reaumur*, or 46 deg. Centigrade, (114 deg. 8, min. *Fahrenheit*.) See page 40.

On the open sea, the temperature of the air, whatever be the place or season, will never attain 25 deg. *Reaumur*, or 31 deg. Centigrade, (87 deg. 8 min. *Fahrenheit*.)

The greatest degree of cold ever observed on our globe with a thermometer suspended in the air, is 40 deg. *Reaumur*, or 50 deg. Centigrade below zero, (58 deg. *Fahrenheit*.) CAPT. PARRY found it only $55\frac{1}{2}$ deg. in the Polar Sea.* The

* *Atheneum* for February, 1821, vol. 8, p. 365.

temperature of the water of the ocean, in any latitude, or at any season, never rises above 24 deg. *Reaumur*, or 30 deg. Centigrade, (86 deg. Fahrenheit.) The foregoing deductions have been made from a general and extensive review of the various experimental data, respecting the temperatures observed at different places on the earth's surface.

It may be proper to observe, that *Reaumur's* thermometer divides the space between the freezing and boiling point of water into 80 deg., and places the zero at the freezing point. The *Centigrade* thermometer places the zero at the freezing point, and divides the range between it and the boiling point into 100. But in *Fahrenheit's*, the one mostly used in England and America, the range between the freezing and boiling points of water is divided into 180 deg.; and as the greatest possible degree of cold was supposed to be that produced by mixing snow and muriate of soda, it was made the zero; hence, the freezing point became 32 deg. and the boiling point 212 deg. (HENRY.)

XVII.

OXYGEN, or the Acidifying Principle.

That distinguished philosopher LAVOISIER, by inferences drawn from analogy with those acids which had been the subjects of chemical analysis, concluded, that *oxygen* was the general principle, or cause of *acidity*. Later experiments appear to have confirmed the foregoing conclusion, and also to have induced the belief, that it was likewise the principle or cause of *alkalinity*.

This latter conclusion is not, however, entitled to our unqualified acceptance; it is in direct violation of the rules of genuine philosophy, which does not admit a physical agent to be possessed of contrary qualities. (*Axiom* 7, p. 8. *prop.* 1, p. 9.) Besides, it has been frankly confessed, that "we have no knowledge of the properties of *oxygen* in a state of complete separation. In the most simple form under which we can procure it, it is combined with *caloric*, and probably with *light* and *electricity*, constituting *oxygen gas*." (HENRY.)

This acknowledgment, besides justifying the views which I have given of its combination with these fluids, in my dia-

gram and classification, afford sufficient ground for contesting the opinion of its being the cause of *alkalinity*.

The chemical properties of this gas are as follows: 1st. That it is not absorbed by water, except in minute portions. 2d. That it is rather heavier than atmospheric air. 3d. All combustible bodies burn in it with greatly increasing splendour. 4th. During every combustion in *oxygen gas*, the gas suffers a considerable diminution. 5th. All bodies, by combustion in oxygen gas, acquire an addition to their weight; and the increase is in proportion to the quantity of gas absorbed, viz. about one-third of a grain for every inch of gas. 6th. Every substance capable of union with *oxygen*, affords by combustion either an *oxide*, an *acid*, or an *alkali*. 7. *Oxygen gas* supports eminently animal life, which effect seems connected with the absorption of oxygen by the blood.

Referring to the sixth property mentioned above, it is understood, that when a body being burnt in *oxygen gas*, affords a compound which has none of those qualities that characterize *acids* or *alkalies*, we denominate this product an *oxide*. Iron burnt in oxygen gas loses its metallic properties, and becomes a brittle dark coloured substance, totally destitute of lustre and of taste, and is then termed an *oxide of iron*. Sulphur burnt in *oxygen gas* over water, the water acquires an *acid* or sour taste, and *potassium*, under the same circumstances, would have yielded an alkali. Hence it is, that oxygen has been thought to be a principle of alkalinity as well as of acidity; and hence, philosophers have concluded also, that "The extensive class of combustible bodies may be subdivided into three orders. 1st. Those which afford oxides by combination with oxygen. 2d. Those which yield acids; and 3d. Those which give alkalies. In many instances, however, a body is capable of passing through the intermediate state of an oxide, before it is converted either into an acid or an alkali."

While I have no hesitation in admitting, that *oxygen* is the general principle or cause of *acidity*, and that there are, under peculiar circumstances, reasons to believe, that acids have been discovered to originate independently, (as it should appear) of *oxygen*, as in the following observation: "And besides, it has been lately proved with respect to *tellurium*, and to the new substance *iodine*, and has been rendered highly

probable with respect to *chlorine*, that those bodies afford acids, not only by uniting with *oxygen*, but also, by combining with hydrogen"—these circumstances cannot be considered as impairing the chemical character of *oxygen* as a general agent or principle of acidity; for *tellurium* is said by KLAPROTH to be composed of 17 parts *oxygen* to 83 parts *base*; and *iodine*, by the intervention of *euchlorine*, forms a peculiar acid with *oxygen*. But, to arrive at the point.

"It is now, however, generally admitted, that the *nitrous acid* is as much a distinct and peculiar compound, as any other of the compounds of *nitrogen*. The proportions of its elements have been investigated by SIR H. DAYY, who finds that two measures of *nitrogen gas*, and one of *oxygen*, (=1 volume of *nitrogen*, and 2 of *oxygen*,) both freed from moisture and mixed together in a vessel previously exhausted of air, are condensed into half their volume, and form a deep orange coloured elastic fluid, which may be called *nitrous acid gas*. To form *nitrous acid*, nothing more is necessary than to saturate water with this vapour." (HENRY.)

By the foregoing process, two important considerations offer themselves to our contemplation. *First*, that combinations of the two antagonist species, *oxygen* and *nitrogen*, in which there is an excess of *oxygen*, result in the formation of *acids*—and, *secondly*, that in combinations in which there is an excess of *nitrogen*, the acid principle is overcome, and the compound is an *alkali*. If these be proved by actual demonstration to be facts by induction, I conceive that I shall fully establish the position which I have taken; and to prove them, I shall advert to the acknowledged and established results of the chemical analysis of those substances immediately connected with the present subject; and by these, shall further prove, by the neutralizing quality of these agents, that *oxygen* is the principle of acidity, but not also of alkalinity.

ANALYSIS OF ACIDS.

EXAMPLES.

1. *Sulphurous and Sulphuric Acids.*

Combinations of oxygen with sulphur, result in sulphurous and sulphuric acid.

Sulphurous acid contains 1 atom of sulphur to 1 atom of *oxygen*.

Sulphuric acid contains 1 of sulphur to 3 of *oxygen*.

The foregoing acids may exist, either in their native or free states, or be combined with other substances, an alkali, an earth, or both. Native sulphurous acid appears to be mostly common to *volcanic districts*. Sulphuric acid, combined with native sulphur, is found in New-York, at Clifton Springs in Farmington, 11 miles from Geneva. (MITCHILL, GODON, &c.)

2. Carbonic Acid.

Oxygen and Carbon, in combination, result in *carbonic acid*. Carbonic acid contains, *oxygen* 71.40; *carbon* 28.60 = to 100. (PEPYS, HENRY, &c.)

This acid exists in the greatest abundance, particularly in volcanic countries; and it abounds also in various other places, as mines, caverns, pits and wells. In the United States there are many springs whose waters contain carbonic acid. Those of Ballston and Saratoga, in the state of New-York, afford it. (CLEAVELAND, MITCHILL, THATCHER.)

3. Boracic Acid.

Oxygen united to *boron*, results in *boracic acid*.

The proportion of the ingredients of this acid, has not been accurately ascertained. It is stated merely as an approximation, to consist of one part by weight of *boron*, united with 2 parts of *oxygen*. (HENRY.)

4. Muriatic Acid.

According to the old theory, combinations of *oxygen* and *sodium* result in *muriatic acid*. The *muriate of soda*, deprived of its water, consists of *muriatic acid* 46. *soda*, (composed of *oxygen*, 13.5; *sodium*, 40.5) 54 = to 100. But by the new theory, it consists of *sodium*, 40.5; *chlorine*, 46×13.5 to 59.5 = to 100. (THOMSON, HENRY, ACCUM, &c.)

5. Nitrous and Nitric Acids.

Combinations of oxygen with nitrogen, or *azote*, result in *nitrous acid gas* and *nitric acid*.

Nitrous acid gas, is composed of 1 volume of *nitrogen* to 2 volumes of *oxygen*.

Nitric acid is composed of 1 volume of *nitrogen* to $2\frac{1}{2}$ volumes of *oxygen*.

To form *nitrous acid*, we have already seen (p. 50,) that nothing more is necessary to be done, than to saturate the gas with water. Nitric acid, as it exists in nitre, will be composed by weight of *oxygen*, 74.03; *nitrogen*, 25.97=100. (RICHTER, PHILLIPS, DAVY, WOLLASTON, THOMSON, HENRY.)

The acid properties of the foregoing combinations, we must take notice, depend mostly upon the predominant or excessive proportion of *oxygen*. In substances therefore, in which its antagonist *nitrogen* predominates, it is both probable and rational to suppose, that the result should be an *alkali*. The arguments and deductions in support of this supposition, will be found in the following section:

XVIII.

Nitrogen, or the Alkalinizing Principle.

After separating from any quantity of atmospherical air, all the *oxygen* which it contains, there remains a *gas*, which was called by LAVOISIER *azotic gas*, a name applied to it in consequence of its unfitness for supporting animal life. This, however, as being merely a negative property, has since been deemed an improper foundation for its nomenclature; and the term NITROGEN GAS has been substituted, because, one of the most important properties of its base is, that by union with *oxygen* it composes *nitric acid*. It has also been termed *septic acid*, and has been suspected by some chemists, particularly Mr. ACCUM, as "entering into the formation of alkalis; and it is considered by some as a real *alcaligen* or alkalinizing principle, in opposition to *oxygen*, which, as we have noticed before, is the principle of acidity." (Vol. 1. p. 174.)

The chemical properties of *nitrogen gas* are; 1. It is not absorbed by water, but in very minute portions. 2. It is a little lighter than atmospheric air. 3. It immediately extinguishes a lighted candle, and all other burning substances. Even phosphorous, in a state of active inflammation, is instantly extinguished when immersed in *nitrogen gas*. 4. It is fatal to animals that are confined in it. And 5. When mixed with pure *oxygen gas*, in the proportion of 4 parts to 1 of the latter, it composes a mixture resembling atmospheric air in all its properties." (HENRY.)

It has been long suspected, that *nitrogen* is not an element, but a compound; and many attempts have been made to discover its ingredients. BERZELIUS, reasoning theoretically, from deductions with other combinations, concludes, that *nitrogen* is a compound of *oxygen*, and an unknown base in the following proportions:

Base,	-	-	-	-	44.32
Oxygen,	-	-	-	-	55.68

100

This base, it must be observed, however, is purely hypothetical; and as it has never yet been exhibited in a separate state, we cannot, at present, know any thing of its properties. BERZELIUS has proposed for this base the name of NITRICUM. It will be recollected, that I have claimed for it the term NITROGENE.

The experiments of MR. MIERS of London, to prove the composition of *nitrogen* by synthesis, seems to warrant the conclusion, that it is a compound of *oxygen* and *hydrogen*, with less *oxygen* than exists in water. These experiments have not been considered as conclusive. It is remarkable, however, that the proportions of the elements of *ammonia*, deduced by MR. MIERS from his experiments, precisely agree with the hypothetical proportions assigned by BERZELIUS, viz. 55.6 *oxygen*, and 44.4 *hydrogen* per cent. weight. (THOMSON'S Annals, 2, p. 284.) The experiments of SIR H. DAVY, (*Philosophical Transactions for 1810*,) directed to the decomposition of nitrogen, on the presumption of its being an oxide, have not been attended with any better success. And it has been concluded, "that the general tenor of these inquiries lends no strength to the opinion, that *nitrogen* is a compound body." (HENRY.)

The conclusion then is, that the properties and qualities of *nitrogen*, have not been as yet correctly ascertained; nor has chemical analysis attained to that perfection, which can enable us correctly to determine on the ingredients of these gaseous substances. It is from reason and analogy, aided by the result of such discoveries as have been made by their imperfect analysis, that we are to determine them. Referring, therefore, to the experiments, and comparing them with those made with the *alkalies*, we may arrive at such facts as will

enable us to draw a fair conclusion in favour of the specific qualities of each individually.

Although the ingredients of *potash*, the most potent among the *alkalies*, appears to have been correctly determined, both by analysis and synthesis, to be the combination of an *acid* with an *alkali*, to wit, *oxygen* and *potassium*; I cannot readily acquiesce in the general conclusion, that it therefore must owe its alkaline properties to oxygen. We have first to consider the various phenomena that occur in the process for obtaining potash. This alkaline substance is obtained only by the incineration of vegetable substances; and it is considered as not pre-existing in these, nor until they are converted to ashes by burning; that then, and only during the process, the alkaline principle is imbibed by the mass, while it is turning to ashes in the fire.

If the incineration is continued beyond a certain point, the ashes are deprived of much of their causticity; and instead of yielding *potash*, a milder alkali termed pearl ashes, can only then be obtained from them; and if the process be still continued beyond that point, the alkaline property is totally destroyed, and the residue is nothing more than an insipid earth called furnace ashes. We thus perceive, that the excessive incineration of these vegetables, does destroy the alkaline principle which they were imbibing in the early part of the process; and it is but rational to infer, that some quality in the air must be the cause of these vegetables acquiring alkalinity.

The quantity of *nitrogen* contained in atmospheric air, would justify the belief; and particularly, as it is itself an incombustible substance, that during the combustion of *oxygen*, this incombustible gas is accumulated in proportions competent to destroy the acid principle of *oxygen*, and to impart its alkaline principle to the ashes with which it enters into a peculiar combination. Part of the *oxygen*, in this process, appears to be driven off, or consumed by combustion; while the incombustible quality of the *nitrogen*, enables it to form a new compound, by combining with the product of the incineration.

Another circumstance demands our attention in this place; it is this: In the chemical analysis of bodies, it is obvious that similar changes take place in them, in the same manner that

they are said to take place in the decomposition of potash; and hence it is often difficult to detect the actual presence of the radiant imponderable etherial fluids, that not only enter into the composition of these bodies, but which are, in truth, the essential cause of their specific characters and properties, and in this instance, give alkaline properties to potash.

“Potash has a very strong attraction for water; this it attracts from the air in such quantity as to dissolve itself. It combines also very powerfully with acids, forming neutral salts, with the sulphuric, nitrous, muriatic, acetic, tartaric, carbonic and other *oxygenated* bases. After these acids have been united to potash, they may be recovered by decomposition of the neutral salt; but they are always found to have undergone some alteration of their properties. There is no more instructive and beautiful example of this, than is afforded by the septic acid in combination with *potash*, producing saltpetre, (*nitrate of potash*,) in which, though neutralized by the potash, yet imparts to it qualities so noxious, that it cannot be safely used internally except in small doses. In the decomposition of saltpetre in close vessels, the septic acid is separated in a very new and altered form. Some action going on between it and the potash, very materially changes the qualities of both, for the alkali is found, on examination, to be as much and as sensibly modified as the acid; their union and their separation work great changes in both. By this change, and its further alteration; by the sulphuric and muriatic acids employed in the decomposition of the saltpetre; and further still, by the heat of the furnace. Exposed to so many causes of new modification and changes, the *septic acid* on being disengaged from potash, assumes another name and other properties. It is less venomous and active than it originally was, and goes by the name of the *nitrous acid*. Even then it is the most powerful and corrosive of all the acids.” (*Amer. Med. Lexicon.*)

It will be seen, that I have taken the liberty of abridging the foregoing original article in the Lexicon, keeping in view, however, the particular design of its author, which I conceive to be that of insisting upon the presence and influence of the *septic acid*, as he terms it, in potash and its nitrate; for this liberty, I hope, I shall obtain the author's indulgence. From the electro-chemical experiments of SIR H. DAVY, recorded

in the Philosophical Transactions for 1808, p. 355, it appears, that potash is not completely deprived of *carbonic acid*, by any process hitherto employed for its preparation. It is further stated, that "it is never quite free from water." (HENRY.)

Perhaps the safest and best criterions from which to ascertain these principles, and to determine on their qualities, will be, to introduce the substances which are the supporters of these qualities respectively, to wit, acids, alkalies, and neutral salts, &c. The following examples are considered appropriate and sufficient to illustrate the principle.

1. *Acids.*

By referring to page 51, it will be seen, that combinations of *oxygen* with *nitrogen*, and in which the *oxygen* is in excess, result in two acids, termed *nitrous* and *nitric*.

2. *Alkalies.*

1. *Potash* is composed of 6 parts of *potassium* combined with 1 of *oxygen*.

2. *Ammonia* is composed of 5 parts of *nitrogen* combined with 1 of *hydrogen*. That is, in 100 measures of ammonia, equal to 60 grains, MR. DALTON obtained 50.09 *nitrogen*, and 10.65 *hydrogen*—gain by process 74—to $\frac{3}{4}$ of a grain. As ammonia is generally considered to originate from animal substances, and potash undoubtedly being of vegetable origin, and as *nitrogen* and *hydrogen* are proved to be its ingredients, may not these gases be also the agents or causes of imparting to the vegetable substances, during their incineration, their *alkaline qualities*? The proposition is a fair one, and is justified by the facts stated in the process for obtaining potash; to wit, that some quality in the air, must be the cause of these vegetables acquiring a property during incineration, which did not previously exist in them; and, that potash is never found perfectly free from carbonic acid and water.

3. *Neutral Compounds.*

1. Atmospheric air, a perfectly neutral mixture, is composed of $3\frac{1}{2}$ parts *nitrogen* to 1 of *oxygen*, with minute portions of *carbonic acid* and *aqueous vapour*. Now, we know that *oxygen* is too active a principle to subserve the purposes of life in its free and uncombined state; and we further know, that *nitrogen* is, by an infinite degree, too *caustic* or delete-

rious, so as to have acquired the term of *azote*, as being privative of life. But, when these gases are combined in the foregoing proportions, they constitute a compound which is neither *acid* nor *alkaline*, but a perfectly neutral fluid, which has been found essential to the health and life of all organized bodies. Again.

2. *Nitrate of potash* (saltpetre) is composed of 49.5 *Potash*, to 50.5 *nitric acid*=to 100. In this combination *potash* has been converted to a neutral salt, by an accession of *oxygen* constituting *nitric acid*; and this has been certainly effected by the surplus quantity of the *acid* overcoming the *alkali*, and neutralizing the compound.

When all these circumstances are taken into consideration, it appears to me an undeniable evidence, that *nitrogen* is entitled to the character of the alkalizing principle of nature, and not *oxygen*; because, it has been clearly shown, that in all acids *oxygen* is the predominant ingredient; in the alkalies, that *nitrogen* predominates; and in the neutral compounds, *oxygen* and *nitrogen*, in certain proportions, are divested of their *acid* and *alkaline* qualities, both of which remain latent or passive in the neutral compound.

I shall close this section with the following remark on the predominance of either the *acid* or *alkaline* principle in the atmosphere, as productive of disease. Many years attention to the states of the air, during the existence of epidemic diseases, has induced me to conclude, that an excess of *alkali* in the atmospheric air, is among the most active causes for the production of typhus diseases; among which, the fatal epidemic of tropical climates, termed yellow fever, also, jail, ship, camp, hospital and country fevers, which are only so many different modifications of the annual, autumnal remittent of tropical countries; and depending upon the greater or less intensity of this caustic, gaseous poison, for generating and supporting the INFECTION which gives rise to these fevers. On the other hand, I consider an excess of the *acid principle* as productive of that inflammatory constitution of the air, which generates and supports *pyrexias* or inflammatory diseases, properly so called. And these states of the atmosphere are indicated by a *deficient electricity*, whenever the alkaline principle predominates, and is evidenced by a dissolved or deliquescent air, loaded with moisture and vapour; or, by a *plus*

or plentiful *state of electricity*, when inflammatory diseases prevail; in which cases the air is usually dry and hot. Lastly, to one or other of these causes also, we may attribute the existence of *exanthematous* or eruptive diseases, from the simple *lichen* to the confluent *variola*.

XIX.

On Motion.

There can be no *motion* without an *impulse*. That which gives *impulse* is a *CAUSE*. Hence, motion is the *effect* of a cause, and not a cause itself, as SIR RICHARD PHILLIPS asserts. This philosopher reviving the doctrine of PLATO, who taught, that "*fire is generated by motion, being the effect of the act and friction of the small particles of bodies,*" has, in a paper published in the London Monthly Magazine for May, 1813, considered *motion* as constituting "the life, power and energy of matter;" and "that it is *the active soul of the universe.*" He further denies the existence of the principle of *gravity*, of *attraction* and *repulsion*; and confidently asserts, that there is no such thing as the electric fluid. I have since seen an extract in which Professor LESLIE of Edinburgh, observes, that "we have no reasons for believing, that there is such a thing as the electric fluid." As I am not in possession of the works of either of these learned authors, and consequently ignorant of the principles upon which they have founded such opinion, it would be premature if not irrelevant, to make any other remarks on this subject, than merely to observe, that whenever these gentlemen shall prove to the satisfaction of their readers, that there is no such fluid in nature as *lightning*, then, and not until then, shall I be persuaded as to the correctness of their assertions. With regard to the remarks on gravity, attraction and repulsion, they are but repetitions of similar objections made by the learned DR. O'GALLAGHER in his "*System of Nature,*" published in 1798, page 11, &c. where he uses the term *pression* for attraction; of which, more will be said under the head of electrical attraction.

All the properties of motion, when fully considered, result in the three following laws. 1st. Every moving body is moved by another. 2d. Every moving body communicates its motion to any body it meets, "and which it is capable of

moving. 3. Every moving body continues in motion, till it communicates that motion to another," or is itself overcome by another body and reduced to a state of rest.

The very idea of motion in bodies, implies an *impelling agent* or cause, and as observed, (vii. p. 15.) the impulse given to matter by the action of the primary agent OXIGENE, is termed *motion* or *action*; and the resistance which matter opposed to the impelling agent, is properly termed *re-action*. And to the *action* and *re-action* of bodies, through the influence of the antagonist agents, are to be attributed all the phenomena of nature. Motion, then, is a principle or quality of bodies, and is not itself a body. The *expansive quality of caloric*, drives or *repels particles* from each other, as from a centre to a circumference, and thus constitutes the centrifugal force of bodies; while the *coercive quality of frigoric draws or attracts particles* towards each other, as from a circumference to a centre, and thus by its re-action, constitutes the centripetal force of bodies. *Motion* is therefore proved to be an *effect* of a cause, or the quality of an agent or agents, and not itself a physical cause. If we consider OXIGENE as the exciting principle of *action*, and NITROGENE as the exciting principle of *re-action*, we have at once a clue to *motion* of all kinds; and as I have already hinted, (page 20,) it is not improbable, that when the animal economy is excited by due proportions of these antagonist principles, the equilibrium of the system is sustained, and all the passions and emotions of the mind, the external and internal senses, and all the functions, are in a capacity to perform their respective offices, and the healthy state of the system is thus supported; but if one principle predominates in undue excess above the other, it unquestionably produces a morbid action either in a part, or of the whole system, as may be evidenced by the disposition of the subjects, to the more violent and discordant passions of the mind, morbid sensibility, morbid and excessive strength, &c., as in spasms, mania, &c.; and in the same manner that the awful and terrible phenomena of nature are evidenced by thunder and lightning, earthquakes and whirlwinds, which are evidently the effects of an excess of one or both these agents, in our atmosphere and earth.

Here, also, we perceive that motion is an effect of a cause or causes exciting it; and I am inclined to think, that these

agents are the cause of that power in the body connected with muscular motion, with its peculiar properties or irritability, as noticed by MR. CHARLES BELL, and which he considers to be superior to all the senses, in the precision which it gives to our perceptions—bestowing on us ideas of distance, of space, of form and substance; that the muscular frame, and the sense which we possess of the muscular frame in action, gives us this power; as for example, the sense of vision in the eye is imperfect until aided by muscular motion; as the sense of touch in the hand would inform us of nothing without the motions of the hand; that hardness, softness, smoothness and angularity are properties of matter, not known to us merely by the sense of touch, but of that sense aided by the motion of the hand; and that the entire and complete exercise of the sense of touch, comprehends a comparison of the exercise of the nerve of touch, with the consciousness of, or the sensibility to, the muscular motion which accompanies it.” In these also it must be obvious, that motion is the effect of one or other of the agents of action or re-action; which proves, that it is not itself a physical cause. . . .

XX.

Chemical Affinities or Attractions.

Matter has been determined by philosophers to possess certain mechanical affections termed their *attractions*, of which they have enumerated five kinds or species. 1st. *The attraction of cohesion*. 2d. *Of gravitation*. 3d. *Of electricity*. 4th. *Of magnetism*. And 5th. *Of Chemical Affinity*. But there is also a mechanical *disaffection* proper to matter, and this property is termed *repulsion*. It cannot but be obvious, that these, together with numerous other terms of science, may be reduced to their primitives—to wit, *action* and *re-action*, which are two qualities opposite to each other, and are proper to all matter. Each of these qualities will be considered separately.

1. *The attraction of cohesion*, is that quality of matter imparted to it by a physical agent, possessing a power opposed to the expansive and repulsive powers of *caloric*; and these powers are inherent in their respective agents by a law of nature, (*Axiom* iii. p. 7;) hence, the attraction of cohesion is one kind of quality or effect that is communicated to matter

in different degrees, according to their chemical constitutions, and is in direct opposition to the qualities of *expansion* and *repulsion*. Consequently, *caloric*, which is admitted to be the cause of the expansive and repulsive principle or qualities of matter, cannot be also the *cause* of the attractive and cohesive qualities of matter; we must therefore seek for some other agent, whose powers are antagonist to those of *caloric*, and this antagonist agent I have termed *frigorific*. (*Synops.* p. 21.)

The *attraction of cohesion* is fully exemplified in the formation of primitive granite, which is essentially composed of crystals of *quartz*, *feldspar* and *mica*, and which crystals cohere by a law of attractive cohesion, without any kind of cement. The crystallization of minerals may be therefore considered as the most striking illustration of this species of attraction, when the crystallization is perfect or complete. The definition of this affection in matter is thus given: "It is considered to be that principle in nature by which the constituent particles of bodies are kept together. By this principle they preserve their forms, and are prevented from falling to pieces." (BLAIR.) It differs, however, very materially in different bodies; for instance, the *diamond* and other precious stones, offer examples of the most perfect character of this principle; while the *soft sand stones* are examples of its more imperfect character. In the former, separation of their particles require the most intense action of *caloric*, artificially applied; while in the latter, the mere touch of the finger is sufficient to separate the mass which crumbles to pieces on being touched. This principle is exerted by bodies only when they are at small distances from each other; and hence the distinction between this principle and the following, which is, in fact, essential to the foregoing.

XXI.

2. *Attraction of Gravitation.*

"By this principle, bodies that are at great distances, tend towards one another." (BLAIR.) This quality is exemplified by the planetary system, in which "the sun gravitates on the planets, the planets on the sun, and on each other; these gravitate on their neighbouring systems, and these again on

more distant ones, and the balance of the universe remains in equilibrio in the hands of the ANCIENT OF DAYS."

This principle varies considerably, and ceases at a given point; thus: "The force of gravity is greatest at the earth's surface, from whence it decreases upwards. It decreases upwards as the *square of the distance* from the centre; and downwards, simply as *the distance*. It is less at the equator than it is at the poles, because the equatorial diameter is 34 miles longer than the polar diameter, and because the swing or centrifugal force of the earth at the equator diminishes the gravity. The force of gravity upwards, decreases as *the square of the distance* from the centre: that is, gravity at the surface of the earth, which is about 4000 miles from the centre, is four times more powerful than it would be at double the distance, or, 8000 miles from the centre. Gravity and weight may be taken in particular circumstances as synonymous terms. We say a piece of lead weighs a pound, or sixteen ounces; but if by any means it could be carried 4000 miles above the surface of the earth, it would weigh only one quarter of a pound, or four ounces." From which it is inferred, that at a given height, it would weigh 0. Because, "it is demonstrated that the force of gravity downwards decreases as the distance from the surface increases; so that at one half the distance from the centre to the surface, the same weight already described, would only weigh half a pound;" (BLAIR;) and when it reaches the centre it will weigh nothing, or, in other words ceases to gravitate.

It is obvious that this definition of gravity can only apply to the substances of our globe; and not to the celestial orbs, or the radiant and imponderable fluids of the firmament, because the sun who is distant from our earth 95,000,000 miles, still gravitates towards the earth and the earth towards the sun, &c.

Under the article *attraction*, in the British *Encyclopædia*, naturalists have classed cohesion, gravitation, magnetism and electricity. They consider attraction as a fifth property of matter, and that it is rather an infused than an inherent property. By the above acknowledgment, it is obvious that these philosophers consider *motion* of every kind, to be a property infused into matter, by some elastic and ethereal power capable of penetrating the inmost parts of all bodies, and by virtue

of these infused forces they tend towards each other in a proper proportion to their bulk and distance. One of the most appropriate examples of this property, or quality of matter, offers itself in the formation of primitive granite, already noticed as an example of cohesion.

While yet, the chaotic mass of primordial matters at the creation were held suspended in a fluid state, (*Sect. VI. p. 14, and VII. p. 16,*) the ponderable matters gravitating to the centre of the forming globe, could gravitate no further, this principle ceased; and the principle of cohesion succeeded to it; hence these matters became crystallized, and formed the most compact rock known as granite, which is supposed to constitute the nucleus of the earth. As a further proof of this quality, many instances are given in works on mineralogy, in which *calcareous*, *siliceous*, and other particles of matter, are held in solution in water, which, penetrating the earth till it is opposed by obstructions which it cannot overcome, make deposits of these particles, that by the attraction of cohesion are made to cohere, so as to form the finest and most perfect specimens of minerals, among which the *agate* is considered a fair example. These stones are said to be formed by the filtration of their particles through the pores of the earth.

The attraction of gravitation is consequently a quality, and not a substance; a property of matter imparted to it by an elastic and ethereal agent, antagonist to the agent of expansion and repulsion.

XXII.

3. *Electrical Attraction and Repulsion.*

The very remarkable properties or qualities that have been discovered in the fluid commonly called the electric fluid, are worthy of particular attention. The agents or causes of the phenomena peculiar to electricity and magnetism, I have distinguished as the two great physical agents of nature, *OXIGENE* and *NITROGENE*. I shall briefly advert to the laws which govern these agents; but in this place, those only which apply to *OXIGENE* or primitive electric light.

1. Two bodies in different electric states, the one *plus* or in the giving state, the other *minus* or in the craving state—when placed within the sphere of electrical influence, if the bodies are ponderous, the fluid that is contained in the *plus*,

rushes to the body that is *minus* with a rapidity so instantaneous, as in some sense, to identify it with its primitive source, the lightning of heaven. This phenomenon is termed by PROFESSOR O'GALLAGHER, its *pression*; but if the body which is *minus* be small and light, such as bits of paper, chaff, &c. they are as instantaneously drawn, or rush to the body which is *plus*, to which they adhere, until they are saturated, in which state they fall to the earth; and this phenomenon has been termed electrical attraction.

2. Bodies that contain the same states of electricity repel each other. This is exemplified by the pith balls, suspended by threads from the prime conductor of an electrical machine; when the balls are charged, both being filled with the same electricity, diverge from each other to the full extent of the threads, if the electricity be *plus*; but if it be *minus*, they diverge to but a small distance; which seems to prove, that the force of *electrical repulsion* is governed by the quantity or intensity of the fluid. The centrifugal forces of the balls cause them to seek in space for substances possessing a different electrical state, to which they may impart their superabundance, and regain their equilibrium, which is a fundamental law of nature. The instant that they part with this superabundant fluid, they gravitate towards the earth, where they remain at rest. This phenomenon is termed *electrical repulsion*, and is, in some measure, similar to *expansion*.

"SIR RICHARD PHILLIPS, who ascribes *attraction* to bodies mutually intercepting the impulse of a universal medium, acting through all space, ascribes *repulsion* to vortices or eddys in the circumambient medium, produced by those peculiar causes which always accompany high degrees of repulsive action. The repulsion of electricity, he considers as merely relative, because every electrified surface has, within a given distance, a contrary electricity; and light bodies, when apparently repelled from one surface, are, in truth, but attracted by the other surface; and perhaps all repulsion is produced by a counter attraction." (BLAIR.) The plain and literal translation of this paragraph is, that there are two opposing forces in nature, the one exciting *action* and the other *re-action*; the one causing *expansion*, the other *contraction*, &c. And the same writer still further confirms this construction of the paragraph, by accounting for the different direction

of bodies influenced by the attraction of gravitation; that is, that a stone or other heavy body let fall, will move towards the earth till it meets with some other body to obstruct its course—that some bodies ascend, because they are acted upon by a force greater than the attraction of gravitation, and in a contrary direction. (See *Blair's Grammar of Philosophy*.)

3. The electric fluid passing from one spherical body to another, has the appearance of a star, or is concentrated, and this appearance is called the electric spark. But when passing from a point to any other body that is not pointed, it is said to form a pencil or brush, because it diverges in every direction from the point to the craving body. If the craving body be also pointed, the fluid passes silently and invisibly from one body to the other. There can be no doubt, that this circumstance led DR. FRANKLIN to recommend sharp points to his *paratonneres* or lightning rods.

I have already, (Sec. x. p. 25,) assigned some reasons for adopting the principles of the present theory, and for transferring this sublime fluid from its improper rank among the species, to its appropriate place as a primary agent, or generic source among the imponderable fluids of the Creation, with the term OXIGENE. The very remarkable phenomena enumerated in the preceding paragraph, affords the most incontestible evidence of the identity of this fluid with light. The transmission of the electric fluid from a point, or from a body having several points, will form a distinct ray from each point, which being decomposed by the surrounding air, presents some one or more of the prismatic colours of light. In clear weather, the rays in day light are of the light colours of the spectrum, viz. a mixture of light and caloric, or red, orange and yellow. In the night, they represent the dark colours, particularly the violet. These rays diverge from the metallic point, in the same way that a ray of light diverges from the prism to the spectrum, as exhibited in the Diagrams 1 and 2; and these are further inducements for classing it as a primary agent. In electro-chemical processes, there appears to be two very distinct species of attraction, evidenced in the decomposition of bodies in the galvanic or voltaic circuit. The following are some of the examples: 1. "When a stream of galvanic electricity is made to act upon water,

(confined in a glass tube properly fitted, with wires inserted through corks at each end,) *oxygen gas* is found at the close of the experiment, in the leg connected with the positive end of the battery, and *hydrogen gas* in that connected with the negative end, and in the proportions which by their union compose water."

2. The experiments of SIR H. DAVY with various neutral salts, invariably resulted in this: that the *acid* collected in the positive cone, and the *alkali* in the negative one. (HENRY'S Elements, vol. 1, p. 168.) Here, then, we discover one end of the battery, that is, the positive or giving end, to attract oxygen or acids; the other end, which is negative or craving, attracts hydrogen or *alkalies*. On this subject DR. HENRY makes the following appropriate remarks, which I request may be attentively considered.

"Thus then a power has been discovered, superior in its energy to chemical affinity, and capable either of counteracting it, or of modifying it according to circumstances. The chemical attraction between two bodies may be destroyed, by giving one of them an electrical state opposite to its natural one; or their tendency to union may be increased, by exalting the natural electric energies. All bodies, indeed, that combine chemically, so far as they have been hitherto examined, have been found to possess opposite states of electricity. Thus, copper and zinc are in opposite states to each other; so are gold and mercury, sulphur and metals, *acids* and *alkalies*."

On this section I would make the following observations with regard to the opposite states of electricity. By the opposite states of electricity, as generally described by authors, we understand, what is usually, though improperly termed, its *positive* and *negative* condition. These terms have not been heretofore either correctly understood nor satisfactorily defined. The truth is, that authors, in explaining them, have made use of its *quantity* to explain its *quality*; and I contend that bodies, whether electrified *plus* or *minus*, are still *positively electrified*, because the electric fluid possesses the same *quality*, though its *quantity* is less. The sun is always in a *plus* or *giving state*; the earth, as it respects that luminary, always in a *minus* or *craving state*. Now it would be unphilosophic to say, in regard to *quantity*, that the earth was *ne-*

gative, because the fluid is always the same in *quality*, (i. e. *positive*,) though deficient in quantity; in which circumstance, it is then *minus* or craving. As it regards the *qualities* of this *fluid*, I consider *positive electricity* to be the pure primitive uncombined electric light, (page 20:) while on the other hand, I consider what is termed *negative electricity*, to be a compound of this electric light, with the etherial matters of darkness and cold, and thus constituting *magnetism*. By a reference to Diagram 1 and 2, and also the scheme for the classification of the etherial fluids, the relative situation of these opposite electrical states will be distinctly seen; as also, that "I consider negative electricity to be in fact magnetism, or the principle of polarity; and this may serve to explain the phenomena of *acids*, being attracted to the *positive*, and *alkalies* to the *negative* end of the battery.* In my theory of the earth, p. 73, while investigating the electrical properties of the *bituminous carbonate of lime*, I have advanced the following *quere*: "Is not the electricity which philosophers term *negative*, identically the same as magnetism? and is not the magnetic virtue derived from that modification of the electric fluid which is considered as negative; and may not the existence of what is termed *positive electricity* in minerals, partaking of the *light colours* of the prismatic rays, being the reverse of that which is found in minerals possessing the *dark colours* of the spectrum, as in the present *bituminous carbonate*, lead to the further confirmation of the fact which I have assumed, that the *oxidizing* and depolarizing rays are actually electric and positive; while the *deoxidizing* and polarizing rays are, on the other hand, actually magnetic and *negative*, as applied to electricity." See *Diagrams No. 1 and 2*.

I will embrace the opportunity afforded me in this section, to repeat what I have advanced in my lectures on this sublime fluid, that OXIGENE entering into combination with animal matter, constitutes the vital principle or life of animals; that one of its modifications constitutes the *nervous fluid*; that the death of animals is caused by the escape of this fluid from

* In the London "Mechanics' Magazine for August, 1825," p. 240, it is observed of the "two electricities," that they "may be distinguished from each other by turning the electrical current, as it issues from a point upon the tongue. The taste of the *positive current* is acid, and that of the *negative current* is more caustic and alkaline."

the system, which has been measurable proved by the resuscitation of persons labouring under *asphyxia* from lightning, drowning, &c. by means of the superinduction of this vital fluid artificially excited, as also in the cure of *hemiplegia*, nervous debility, &c. That a similar influence is exerted in the vegetable kingdom, in which it constitutes the *vegeto-nervous fluid*; and even in the mineral kingdom, its influence is manifested in several instances, recognized in the electrical properties of these substances, &c. (*Lect. vii. page 9, and sequel.*)

XXIII.

Magnetism.

The wonderful properties of the loadstone, have been the subject of inquiry among naturalists, almost as early as the properties of amber, which lent its name to the etherial electric fluid. PLATO seems to have understood something of the impulsive force which occasions iron to be drawn to the loadstone, though he would not call it *attraction*, because he did not allow that there was any such cause in nature. LUCRETIVS, DES CARTES and PLUTARCH, endeavoured to assign a reason for this property, by supposing, "A vortex of corpuscles or magnetic matters, which, continually floating around the loadstone, repelled the intervening air between itself and the iron. The air thus repelled becomes a vacuum, and the iron finding no resistance, approached with an impulsive force, pushed on by the air behind it. The latter philosopher applies the following appropriate query: 'Why the vortex which circulates round the loadstone, does not make its way to wood or stone as well as iron?' Because, says he, the pores of iron have an analogy to the particles of the vortex circulating about the loadstone, which yields them such access as they can find in no other bodies whose pores are differently formed."* Thus much has been noticed, to show that the ancients were not wholly ignorant of the loadstone.

The most remarkable property of the loadstone is its polarity, which it imparts to *iron* and *steel*, (also to *Nickel*, *Chromium* and *Cobalt*,) which former are thence termed magnets;

* WESLEY'S Philosophy, vol. 2, p. 385.

these have a constant tendency to the poles. The next remarkable property is its attraction for iron and steel, and of such other metals of which iron or steel are ingredients. Other remarkable properties of the loadstone, prove it to be of electrical origin. The principles of attraction and repulsion, are governed by the same laws that govern electricity. It has been already shown, that bodies possessed of the same states of electricity repel each other, while the bodies that are possessed of different states, one positive, the other negative, attract each other, (p. 64.) And magnets, if made to approach each other with the same poles, invariably repel each other; but, if the north pole of one be presented to the south pole of the other, they are attracted towards each other. Thus, we see, that polarity is one of the laws of nature, and inherent in NITROGENE as a primary agent, and by which it is imparted to *magnetic iron ore*, adapted to its uses in a super-eminent degree, and further concentrated in the magnetic iron stone, known as the loadstone. Other metals have been since found to possess, in a less degree, the principle of polarity; and even *iron sand* and minerals have been discovered to have their electrical poles, (of which more will be shortly said,) which seems further to prove the existence of this law of nature, as inherent in the two great physical agents of nature.

The striking analogy between *magnetic* and electric, attraction and repulsion, is acknowledged by most philosophers. Some of them, however, seem to infer, that "it is something like magnetism which gives polarity to electricity." (MAYO.) This opinion must yield to the facts already established, and which go to prove, that the magnetic virtue is derived from the *violet* or polarising ray of light, (p. 21.) On this subject it may be proper briefly to notice, that *heat* represented by the *red ray* in the diagram, depolarizes or destroys the magnetic principle of magnets; but the rays marked *blue*, *indigo* and *violet*, being compounds, or oxides of *positive electricity and darkness*, and hence *negative* in being thus compounded, restore or give the magnetic property to steel or iron, in the same manner that the most perfect loadstone is known to do. Hence it is a *chemical fact*, as well established as any chemical fact can be, that the magnetic iron ore, &c. derive their magnetic properties from the dark coloured rays of the spectrum or *electrical oxides*, and not

magnetism giving polarity to electricity, as asserted by some; nor is it a property derived from the earth, as CAVALLO, DR. HALLEY, and several other philosophers suppose; but derived from the unceasing, universal influence of the primary agents upon the substances of the globe; and for which principles, i. e. *electric* and *magnetic* metals have the greatest mechanical affections, and hence also, their electric and magnetic poles. Whoever doubts the foregoing, let him read WERNER'S Observations on the properties of Iron Sand; in THOMSON'S Chemistry, or COLONEL GIBBES' letter to PROFESSOR SILLIMAN of Mass.; on the polarity of light, &c., the properties of magnetic ore, &c., and published in his Journal of Science. I am therefore disposed to conclude, that all these circumstances taken into consideration, *magnetism* and *negative electricity*, so denominated, are nothing else than the same fluid differently modified.

XXIV.

Chemical Affinity.

As this subject embraces several important facts, that are essential to the establishment of the present theory, I shall avail myself of the advantages afforded in the scientific "ELEMENTS OF EXPERIMENTAL CHEMISTRY," by DR. HENRY of Manchester.

"Chemical affinity, like the cohesive attraction, is effective only at insensible distances; but it is distinguished from the latter force, in being exerted between the particles or atoms of bodies of *different kinds*. The result of its action is not a mere aggregate, having the same properties as the separate parts, and differing only, by its greater quantity or mass, but a new compound, in which the properties of the components have either entirely or partly disappeared, and in which *new qualities* are also apparent. The combinations effected by chemical affinity are permanent, and are destroyed only by the interference of a more powerful force, either of the same or of a different kind."

"As a general exemplification of chemical action, we may assume that which takes place between *potash* and *sulphuric acid*. In their separate state, each of these bodies is distinguished by striking peculiarities of taste, and by other qualities. The *alkali*, on being added to blue vegetable infusions,

changes their colour to *green*, and the *acid* turns them *red*.^{*} But if we add the one substance to the other very cautiously, and in small quantities, examining the effect of each addition, we shall, at length, attain a certain point at which the liquid will possess neither *acid* nor *alkaline* qualities; the taste will be converted into a bitter one; and the mixture will produce no effect on blue vegetable colours. Here then, the qualities of the constituent parts, or at least some of their most important ones, are destroyed by combination. When opposing properties thus disappear, the bodies combined have been said to *saturate* each other; and the precise term at which this takes place, has been called *the point of saturation*. It is advisable, however, to restrict this expression to weaker combinations, where there is no remarkable alteration of qualities, as in cases of solution; and to apply to those results of more *energetic affinities*, which are attended with loss of properties, the term *neutralization*.[†] The reader is requested to reconsider what I have advanced in the XVII. and XVIII. Sections, and particularly page 56, on *neutral compounds*, compared with the foregoing paragraph.

“At the same time that the properties of bodies disappear on combination, other new qualities, both sensible and chemical, are acquired; and the affinities of the components for other substances become, in some cases, increased; in others, diminished in energy. Sulphur, for example, is destitute of taste, smell, or action on vegetable colours; and *oxygen gas* is, in these respects, equally inefficient. But the compound of *sulphur* and *oxygen* is intensely acid; the minutest portion instantly reddens blue vegetable infusions; and the acid is disposed to enter into combination with a variety of bodies, for which its components evinced no affinity.[†] Facts of this kind sufficiently refute the opinion of the older chemists, that the properties of compounds are *intermediate* between those of their component parts; for in instances like the foregoing, the compound has qualities, not a vestige of which can be traced to either of its elements.”

* The reader is requested to compare this part of the paragraph with what I have said on the influence of acids and alkalies on the prismatic colours of light, p. 34.

† This principle will be fully illustrated in the section which treats of the reduction of compounds to their primitives, by chemical analysis.

"It is not, however, in all cases, that the change of properties is so distinct and appreciable by the senses, as in the instances which have been just now described. In some examples of chemical union, the change is scarcely perceptible to the eye or taste, when the chemist is nevertheless certain, that combination must have taken place. This occurs chiefly in the mixture of saline solutions with each other, where a complete change of principle ensues, without any evident change of properties. Examples of this kind cannot, however, be understood, till the subject of *complex affinity* has been first elucidated. The existence of chemical affinity between any two bodies, is inferred, therefore, from their entering into chemical combination; and that this has happened, a change of properties may be considered as a sufficient proof, even though the change may not be very obvious, and may require accurate examination to be perceived at all."

"Beside the alteration of properties which usually accompanies chemical action, there are certain other phenomena which are generally observed to attend it."

1. In almost every instance of chemical union, the *specific gravity* of the compound is greater than might have been inferred from that of its components, and this is true, both of weaker and more energetic combinations. When equal weight of *water* and *sulphuric acid* are made to combine, the specific gravity of the resulting liquid is not the mean, but considerably greater than the mean. The law extends also to solids; but, though general, it is not universal; for, in a very few instances, chiefly of *aëriform fluids*, condensation does not attend chemical union. And in the combination of metals with each other, the reverse even takes place, the compound being specifically lighter than might have been expected, from the specific gravity of its elements, and their proportion to each other. It cannot but be obvious, that the increased gravity alluded to in the foregoing paragraph, is caused, (in the mixture of *water* and *sulphuric acid*,) by the quantity of *caloric*, which is generated and absorbed by the process; other qualities may be also generated or elicited by other combinations; but being of the *aëriform species*, are not so immediately detected; as a proof of which, it has been noticed, that in the chemical analysis of numerous substances, from 2 to 5 per cent. cannot be accounted for; which proves,

that during the artificial decomposition of these substances, the foregoing proportions of them being *aëriform*, escaped without notice, owing to the yet imperfect state of the apparatus used for those nice and important processes; and this defect has been greatly lamented by SIR H. DAVY, and other eminent practical chemists. When such a *desideratum* is attained, I venture to assert, that *nitrogen* will be detected as an ingredient in many compounds; in which, not the most distant idea of its existence has, as yet, been suspected.

2. "When bodies combine chemically, it may be received as a general fact, that their *temperature* changes. Equal weights of oil of vitriol and water, at 50 deg. of *Fahrenheit*, are heated by sudden mixture to considerably above 212 deg. In other examples a contrary effect takes place, and a diminished temperature, or, in other words, a production of *cold* is observed." (See sec. xvi. p. 43.)

3. The *forms of bodies* are often materially changed by chemical combination; two solids may, by their union, become fluid, or two fluids may become solid. Solids are also often changed into *aëriform* fluids; and, in many instances, the union of two airs, or *gases*, is attended with their sudden conversion into the solid state.

4. Change of *colour* is a frequent but not universal concomitant of chemical action. In some cases brilliant colours are destroyed, as when *oxymuriatic acid* is made to act on solution of indigo. In other instances, two substances which are nearly colourless, form by their union a compound distinguished by beauty of colour, as when *liquid potash* is added to a very dilute syrup of violets. Certain colours appear also to belong essentially to chemical compounds, and to be characteristic of them. Thus, 100 parts of quicksilver, and 4 of *oxygen*, invariably give a *black compound*, and the same quantity with 8 parts of *oxygen*, a *red compound*.

In the chemical combination of bodies with each other, a few leading circumstances deserve to be remarked.

1. Some bodies unite in all proportions; for example, water and sulphuric acid, or water and alcohol.

2. Other bodies combine in all proportions as far as a certain point; beyond which, combination no longer takes place. Thus, water will take up successive portions of common salt,

until at length it becomes incapable of dissolving any more; in other words, the water is saturated.

3. There are many examples in which bodies unite in one proportion only; and in all such cases, the proportions of the elements of a compound must be uniform for the species. Thus, *hydrogen* and *oxygen* unite in no other proportions than those constituting water, which, by weight, are very nearly $11\frac{1}{2}$ of the former to $88\frac{1}{2}$ of the latter, or 1 to $7\frac{1}{2}$.

4. Other bodies unite in several proportions; but these proportions are definite, and in the intermediate ones no combination ensues. Thus, 100 parts by weight of charcoal combine with $132\frac{1}{2}$ of *oxygen*, or with 265, but with no intermediate quantity; 100 parts of *manganese* combine with 14 of *oxygen*, or with 28, or with 42, or with 56, and with those proportions only.

“Now it is remarkable, that when one body enters into combination with another, in several different proportions, the numbers indicating the greater proportions, are exact simple multiples of that denoting the smallest proportion. In other words, if the smallest proportion in which B combines with A be denoted by 10, A may combine with twice 10 of B, or with three times 10, and so on, but with no intermediate quantities.” To this species of combination, MR. DALTON has applied the terms “*binary*, *ternary* and *quaternary* combinations.” It is impossible, in a work like the present, intended merely as an outline, or *synoptical view* of a general system of philosophy, to enter into a detailed account of the various phenomena connected with this subject, especially as chemical works are in the hands, or within the reach of every class of readers. I shall, however, conclude this section with the following peculiarities, to some of which I shall have occasion to refer, in the course of the succeeding sections.

“An important law of affinity, which is the basis of almost all chemical theory, is, that one body has not the same force of affinity towards a number of others, but attracts them unequally. Thus, A will combine with B in preference to C, even when these two bodies are presented to it, under equally favourable circumstances; or, when A is united with C, the application of B will detach A from C, and we shall have a new compound consisting of A and B—C being set at liberty,

or is precipitated to the bottom. Such cases establish the chemical law termed *single elective affinity*.

Several causes are found to modify the action of chemical affinity. When two substances are opposed to each other with respect to a third, they may be considered as *antagonist forces*, and they share the third body between them in proportion to the intensity of their action. Thus, *potash* separates *oxalic*, *phosphoric* and *carbonic acid* from *lime*. Either *lime* or *soda* separates *sulphuric acid* from *potash*, and *nitric acid* separates *lime* from *oxalic acid*.

Cohesion, insolubility, great specific gravity, elasticity, temperature, the electrical states of bodies, mechanical pressure, &c. are among the most important circumstances that modify the exertion of chemical affinity. Under the more general name of *complex affinity*, BERTHOLLET includes that which has hitherto been considered as produced by the action of four affinities, and which has been denominated *double elective affinity*. It frequently happens, that the compound of two principles cannot be destroyed either by a third or a fourth, separately applied; but if the third and fourth be combined, and placed in contact with the former compound, a decomposition or a change of principles will ensue. For examples of this, and further illustrations of chemical affinities, the reader is respectfully referred to the 1st volume of HENRY'S Chemistry, pp. 36 to 72.

The foregoing sections may be considered as containing an abridged view of the author's Elements of Philosophy; having, however, a reference to the principles upon which he has founded his Theory of the Earth. The following sections imperceptibly lead to a condensed view of those principles, and are to be considered merely as sketches of the work.

PART II.

XXV.

Crystallization.

It has long been the subject of particular notice, that all the substances of nature that are susceptible of crystallization, have also a powerful tendency or disposition to assume a peculiar shape. In consequence, however, of the numerous op-

posing forces, their tendency to this ultimate state, is either partly prevented or wholly destroyed. Hence, the great variety of imperfect crystals, both natural and factitious.

Enough, however, has been ascertained by the unwearied diligence and attention of philosophers, to prove, that there is a natural tendency in certain bodies to reach their ultimate state of perfection, that of a purity of substance, and a peculiar or specific shape, which has obtained for these bodies the name of crystals. By consulting the works of the celebrated BERGMANN, ROME DE L'ISLE, WOLLASTON, BEUDANT, the ABBE HAUY, the COUNT BOURNON, and other celebrated mineralogists, it will appear, that notwithstanding the numerous crystals, amounting to an almost incredible variety of primary and secondary forms; hitherto, they have been able to reduce them, by the rules of mechanical division, to the seven following primitive forms, viz. 1. A *cube*. 2. A regular *tetraedron*. 3. A *dodecaedron*, with rhombic faces. 4. An *octaedron*, with triangular faces. 5. A *rhomb*. 6. A four-sided prism. And 7. A regular *hexaedral prism*. Again, these seven primitive forms have been reduced to three, viz. 1. The *tetraedron*, the simplest of pyramids. 2. The *triangular prism*, the simplest of prisms. And 3. The *parallelepipedon*, including the *cube* and *rhomboid*, the simplest of solids, which have their faces parallel two and two; and these three constitute what has been termed the *integrant molecules* of crystals.

To give some idea of the extensive variety of forms, I will barely advert to a paragraph in CLEAVELAND's Mineralogy, under the article carbonate of lime, where it is remarked, that "The COUNT BOURNON has described no less than 616 varieties of forms belonging to the crystals of this important mineral; besides 63 additional forms arising from a greater or lesser extent of the faces of these crystals." My object is not, however, to particularize the extensive variety, but to endeavour to arrive at the principles governing those formations.

The *expansive* quality of *caloric*, and the *coercive* and *cohesive* quality of *frigoric*, are obviously the alternate agents or causes for conducting the entire processes of crystallization. In the second diagram, the influence of these antagonist agents, may be seen in the diverging and converging rays of light; and we have only to conceive the *integrant molecule*

of the crystal defined by the diagram, to be a triangular prism; and two of which, united at their bases, constitute an acute *rhomboedron*, which is the form of the crystal represented by the entire diagram, Fig. 2.

This figure has been chosen, because of its immediate illustration of the divergence or decomposition of the solar beam on the one hand, and its convergence or recombination on the other; which divergence and convergence of the rays of light, are to be considered as constituting a law of nature, governing the degrees of its refrangibility, and its consequent action and influence upon the different substances of nature, and particularly in the processes of crystallization. It is easy to conceive the changes that will be produced on this figure, by admitting the different degrees of refrangibility of each ray influencing the formation, as may be seen by the rhomb or cube represented by dotted lines, that has been obviously produced by the refraction of the rays of light. Hence, the influence of these refracted rays, in converting a triangular prism into a cube; and did the limits of this essay admit, it would be easy to prove in what manner the seven primitive forms of crystals were produced, by taking particular cognizance of the different degrees of refrangibility of each ray respectively. I have, however, offered this section on crystallization merely as a hypothesis, in the hope that it may induce some individual better qualified than myself, to give to this subject that reflection, which appears to me to be due to it; and that perfection, which, from my deficiency of mineralogical knowledge, it is impossible for me to give to it. I can only repeat in this place my firm impression, that the seven primitive crystals have each derived their forms from the action of the seven prismatic rays, in their divergence, convergence, &c. agreeably to the influence of these rays by a law of nature; and that these forms are capable of furnishing an infinite variety of secondary forms, depending upon the particular refractions of light; and further, that the properties and colours, as well as the form and structure of crystals, are influenced and determined by these rays; hence, their polarity, their electric and non-electric properties when perfect; but when their perfection has been prevented by any casual disturbance during their formation, or by the accidental accession of bodies foreign to their specific composition and charac-

ters, these properties, whether of structure, colours, or influence, are more or less impaired, lessened, or destroyed.

XXVI.

Reduction of all the Substances of Nature to their Primitives.

The first division of the primordial matters of the Creation having been defined, as "*the great primary physical agents of nature,*" or the two forces to which all the bodies in nature are subject, and having proved, that by the expansive properties of *caloric*, solid bodies are converted into liquids, and liquids into aeriform fluids or gases; and on the other hand, that by the coercive properties of its antagonist *frigorific*, fluids are converted into liquids, and liquids into solids, as one or other of these forces prevail: I shall now proceed to the reduction of all the ponderable and tangible substances of nature to their primitives, agreeably to the established results of the reiterated investigations and analysis of those substances, by the most experienced chemists of the present age.

From these investigations it has been ascertained, that all the ingredients that enter into the composition of bodies, whether organized or unorganized, consist of the following seven natural divisions, viz.

- | | |
|--------------|-------------------------|
| 1. Oxygen. | 5. Simple Combustibles. |
| 2. Acids. | 6. Metals. |
| 3. Alkalies. | 7. Water. |
| 4. Earths. | |

The foregoing arrangement is to be considered as the simple natural division of substances, because, combinations of two or more of these, result in an innumerable variety of compounds, which constitute all the bodies in the universe. The above arrangement is given by *Professor CLEAVELAND*. I would substitute *atmospheric air* in the place of *oxygen*; as being a compound of *oxygen* and *nitrogen*, by this improvement, it will be readily perceived, that *acids* and *alkalies*, or the 2d and 3d divisions, are derived from the first; or, in other words, the influence of these two agents, *oxygen* and *nitrogen*, upon the primitive earth, may be considered as having produced the 2d and 3d division, viz. *acids* and *alkalies*. Hence, the 2d, 3d and 4th divisions, are resolved into their primitives, viz. *earth* and *air*. Metals are asserted to be the base of earths; and there can be no kind of doubt, that the ac-

tion of the great physical agents, upon *earth* and *water*, have resulted in the production of *hydrogen*, *carbon* and *sulphur*, the three simple combustibles which constitute the 5th division. Hence, the 5th and 6th divisions are also resolved into their primitives, *earth* and *water*; from whence, it is reasonable to conclude, that the seven natural divisions will very properly be represented by *air*, *earth* and *water*; or, as arranged in the classification, page 23 and sequel.

Oxygen and Nitrogen	}	Constitute atmospheric air, which act as agents.
Acids, Alkalies, Earths, Combustibles, Metals,		
	}	Afford subjects for the action of these agents.

Water. The great and universal menstruum, which, reduced to its primitives, is resolved with *oxygen* and *hydrogen gases*.

XXVII.

Reduction of Acids to their Primitives.

The influence of OXIGENE, the great primary agent of nature, as exerted by its species *oxygen*, in combination with particular bodies, constitutes acids. Hence, the 12 following *simple acids of nature* are referrible to this section. 1. *Carbonic*. 2. *Phosphoric*. 3. *Fluoric*. 4. *Sulphurous*. 5. *Sulphuric*. 6. *Muriatic*. 7. *Nitric*. 8. *Boracic*. 9. *Chromic*. 10. *Molybdic*. 11. *Arsenic*. 12. *Mellitic*. "These acids occur chiefly in combination with the *alkalies*, *earths* and *metallic oxides* forming salts." CLEAVELAND. We here discover one of the fundamental provisions or laws of nature, the presence of one or both of the primary agents, or their species, in almost all the substances of nature; hence, the *acids* entering into combination with the *alkalies*, *earths*, and *metallic oxides*, constitute a new order of bodies termed *salts*; and we shall soon discover, that it is to the predominant influence of one or other of these agents or forces, that all the bodies in nature are composed and retained in their fluid, liquid or solid states, and are again decomposed and reconverted by an innumerable variety of changes, into their original primitives, *air*, (or etherial fire) *earth* and *water*.

The decomposition of the foregoing simple acids reduce them to their primitives, first by *proximate*, and lastly by ultimate *analysis*. The ultimate analysis of these acids, therefore, show that *carbonic acid* is a compound of *oxygen* and *carbon*. *Phosphoric acid*, a combination of *oxygen* and *phosphorus*; *fluoric acid*, a compound of *oxygen* and *fluor spar*, &c. &c. In all these substances, therefore, oxygen has been proved to be the cause of their acidity; and with a few exceptions, it may be very properly considered as the *acidifying principle of nature*.

XXVIII.

Reduction of Alkalies to their Primitives.

I have previously observed, (page 23) that NITROGENE, the ethereal principle of darkness, with its species, in their combinations produce all orders of solids; that its species *nitrogen* is a constituent in *atmospheric air*, in all *alkalies*, in some *acids* and *earths*. By a reference to sect. xviii. p. 53, the ingredients which constitute *alkalies* will be distinctly ascertained, as far as chemical analysis has succeeded in the development of their actual constituents. It is acknowledged, that much is yet wanting to render the experiments less imperfect and more conclusive; until then, we must rest the issue of this article upon what has been advanced in the 18th section, and particularly at page 57; which is, that in those substances in which *oxygen* and *nitrogen* are found as ingredients, those in which *oxygen* predominates, acquire acid qualities; while those in which *nitrogen* is the predominant ingredient, acquire alkaline properties. Hence, *nitrogen* may be very properly considered as the *alkalinizing principle of nature*.

XXIX.

Reduction of Earths to their Primitives.

From an attentive examination of the results of the chemical analysis of all orders of bodies in the three kingdoms of nature, and particularly the mineral kingdom, to which my attention has been most particularly directed, it has been satisfactorily proved, that these numerous bodies, diversified in their structure, qualities, colours, and general characters, are all derived from at most ten kinds of earths, variously

combined, with *acid* or *alkaline* substances. By pursuing this subject still further, we are at length brought to the almost unavoidable conclusion, that originally, or at the creation of our globe, there was but *one primitive earth* suspended in the primordial mass of fluids; and from the abundance, importance and frequency of its presence in all other bodies, and particularly in the essential constituents of our globe, the earth *silex* may be considered as the *primary earth*, or primitive deposit of nature, and of which the nucleus of our globe has been commenced.

At present, there has been actually ascertained ten kinds of earth, viz. 1. *Silex*. 2. *Alumine*. 3. *Lime*. 4. *Magnesia*. 5. *Barytes*. 6. *Strontian*. 7. *Zirconia*. 8. *Glu-cine*. 9. *Yttria*. 10. *Thorina*. The four first named of these earths, are more abundant and important than all the others; the remaining six, with the exception of *Barytes*, are rare, and occur but in small quantities. In the WERNERIAN arrangement, *granite* is considered as a primitive formation, and is the lowest rock towards the earth's centre that has ever yet been discovered. The ingredients of this rock are *quartz*, *feldspar* and *mica*, each perfectly crystallized, and united together by the most perfect cohesion without any cement, as already noticed, page 16. The ingredients of this rock are chiefly *silex*. In primitive *quartz* it is entire; in *feldspar* it amounts to 71 per cent., the balance being composed of *alumine* and *oxide of iron*. In primitive *mica*, *silex* and *alumine* are the essential ingredients; hence, the supposed nucleus of the earth, is essentially composed of *silex* and *alumine* in three proportions, constituting three distinct minerals.

Of the 3d earth, *lime*, we do not find it to be an ingredient in any of the primitive formations, until it is discovered in clay-slate, the 5th set of WERNER'S Grand Formations. The fact is, that lime did not appear among the primitive earths, until after the existence of marine animals, madrepores and shells. These animals, either driven by the tides of the ocean, or deposited by its currents into beds at the feet of the primitive rocks, and afterwards abandoned by the ocean in its continued subsidence, where being exposed to the influence of the atmosphere, became decomposed, and uniting with the acids, constituted several species of salts, whose bases are now

known as the alkaline earth called lime. And it may save us much unnecessary reflection briefly to observe, that particles of lime near the surface of the earth, being dissolved by water, is thus held in solution of a most impalpable form; which calcareous water descending through the pores of the earth, until obstructed by the impervious granite or other rock, there makes its deposite, and constitutes the richest and finest beds of *gypsum* and of marbles, whose variegated colours are derived from the various *metallic oxides* which the lime water may chance to pass through in its passage or filtration to its destined bed. It will be hence clearly perceived, that all the finer and more perfect specimens of gypsum and of marbles, of the transcendantly beautiful *stalactites* and *stalagmites* of the wonderful limestone caverns, as indeed all the precious stones or gems, the *diamond* perhaps only excepted, have been all produced by this kind of solution and filtration.

It must be observed, that with the exception of granite, the primitive rocks are either slaty or foliated; in other words, their structures are not so compact or firm, but that they will admit the accession of foreign bodies into their composition; hence, by the continued filtration and deposite, which have been going on since the Creation, each primitive set of rocks have received various foreign bodies; that, together with the many new combinations, resulting from the decomposition of one or more of the primitive rocks, geologists can now enumerate the addition of 8 formations to the 7 primitive sets, or first grand class, 6 to the 7 transition rocks, 9 to the 10 floetz rocks, and 4 to the 2 alluvial formations, making a grand total of 60 kinds, or sets of rocks, besides a number of varieties, and also volcanic formations not enumerated.

Professor CLARKE of Cambridge, England, considers each of the earths as a metal, which, in our atmosphere, can exist only as an oxide. Consequently, there must be thirty kinds of earth, as there have been thirty metals ascertained, and which have been considered as the bases of as many earths. We have already seen, that only four of these earths are either abundant or important in the composition of bodies. The remaining 26, ten only of which have as yet been discovered, are therefore to be considered as the result of the natural or adventitious decomposition of some previous earth, constitut-

ing a new *oxide*; or, combinations of two or more of the primitive substances of nature, resulting in a new compound, of which we shall presently have abundant proofs.

"The *acids*, *alkalies* and *earths*, are known to be compounds of *oxygen*" (and *nitrogen*,) "with peculiar bases, which, in most cases, appear to possess metallic properties more or less distinctly. Thus, potash is a compound of *oxygen*, and a base called *potassium*; *silex* is a compound of *oxygen*, with a base called *silicum*,* or *SILICON*. Hence, the *alkalies* and the *earths* may, without impropriety, be considered *oxides*, as in Professor CLARKE's arrangement of minerals, where the earth *silex* is called *oxide of silicum*, *barytes*, *oxide of barium*," &c. (CLEAVELAND.) It will hence appear, that the bases of our earth at the Creation were held in solution, as metallic bodies are now held in solution in acids, or, as the ingredients constituting meteoric stones, are held in solution in the gaseous fluids of our atmosphere, retaining, nevertheless, their primitive and essential qualities as metals, and their inherent principles of becoming again resolved into their primitives; and hence, the number of their combinations, as *alloys*, *sulphurets*, *oxides*, *chlorides* and *salts*.

We may therefore readily account for the origin of the 4th earth *magnesia*, as indeed all the remaining earths, by a reference to the virgin earth *silex*. The abundance of this body at the Creation, cannot be doubted to have been sufficient for all the purposes for which it was designed. SIR H. DAVY has satisfied himself that the base is a combustible substance, being analogous to charcoal, sulphur and phosphorous. This base being held in solution in the mass of fluids at the Creation, was, by the action of OXIGENE, inflamed, and the *first grand chemical process* constituted for the formation of solids, by the *expansion* and *rarifaction* of the ethereal fluids, and the antagonist action of NITROGENE, by its coercive and cohesive powers causing re-action, the accumulation of the integrant particles of solids began to gravitate to the centre, and *silex* or the primitive earth, was created or made.

* "In his attempts to obtain the base of *silex*, SIR H. DAVY has been hitherto unsuccessful." In his more recent experiments, it is added, "The base, Sir H. now believes not to be a metal, but a substance most resembling *boron*, and like it bearing an analogy to charcoal, sulphur and phosphorous." (HENRY, vol. 1, p. 216.)

From the very nature of the base of this earth, according to that eminent chemist, and from the natural chemical action of the primary agents upon this subject, it is obvious, that a pure virgin or primitive earth, was separated from the mass; and that *carbon*, *sulphur* and *phosphorous* were produced by this grand process; and further, the action of these agents upon the universal menstruum, the waters of the ocean, resulted in the formation of *soda*, or the mineral alkali; combinations of which, with *oxygen* and *sulphur*, resulted in the formation of the second named earth, *alumine*, in which, a portion of *nitrogen*, or the alkaline principle of nature, is always detected in the form of potash. Combinations of these two minerals, *silex* and *alumine*, constitute the solid nucleus of the earth, which the immortal WERNER has ranked as the first primitive rock of our globe, and by which all the subsequent formations are supported, and from which they are derived.

XXX.

Further proofs that Silex is a Primitive Earth.

On consulting the works of the most eminent geologists and mineralogists, it will be seen, that of the seven natural divisions of the mineral kingdom, (xxvi. p. 78,) there have been ascertained the following substances, that are the results of the chemical combinations of two or more of the substances constituting those divisions:

- | | |
|-----------------------------------|---------------------------|
| 1. Combustible bodies ascertained | 41 species and varieties. |
| 2. Alkaline earths and salts, | 128 |
| 3. Earthy compounds or stones, | 332 |
| 4. Ores of metals, &c. | 256 |

Total, 757 species and varieties.

Of those substances, the earthy compounds or stones demand our present consideration; and first of simple earths and stones.

1. *Silex*.

Twenty-six minerals, essentially composed of this earth, and which have never yet been seen crystallized or transparent, form the first division of silicious stones. These are,

1. CATSEYE. 2. CHALCEDONY, common; *cacholong*, *sarnelian*, *sardonyx* and *plasma*. 3. SILICIOUS SINTER with its varieties, *hyalite* and *michaelite*. 4. HELIOTROPE. 5. CHRYSOPRASE. 6. OPAL, with its varieties, *precious* and *common opal*, *hydrophane*, *girasol*, *semi-opal*, *menelite* and *opalized wood*. 7. FLINT, var. *swimming flint*. 8. HORNSTONE, var. *agatized wood*. 9. SILICALCE. 10. BUHR STONE. 11. JASPER, var. *common*, *striped*, *Egyptian*. *Total*, 26.

Twenty-six minerals, composed of *silex*, nearly or entirely pure, though often occurring in amorphous masses, are very frequently in crystals, which in perfection and beauty, are not exceeded by those of any other mineral. (CLEAVELAND.) They constitute the second division of silicious stones or the quartz family, of which there are 26 species and varieties. We have thus 52 minerals, whose chemical analysis give from 84 to 99 per cent. *silex* to the hundred, the balance consisting of *oxide of iron* and water.

2. Compound Stones.

Thirty-nine combinations of *silex*, with other substances, result in the formation of 270 species and varieties of minerals or stones; of these I shall only point to the combinations, and refer the reader for the species and varieties to PROFESSOR CLEAVELAND'S invaluable Treatise on Mineralogy.

1. Combinations of Simple Earths.

- | | |
|---------------------------------------|---------------------------------|
| 1. Silex, alumine and glucine. | 5. Silex, magnesia and alumine. |
| 2. Silex, alumine and magnesia. | 6. Zirconia and silex. |
| 3. Silex, magnesia and lime. | 7. Silex, alumine and lime. |
| 4. Silex, alumine, lime and magnesia. | |

2. Combination of Earths with Water.

- | | |
|--|---|
| 1. Alumine and water. | 10. Silex, magnesia, alumine and water. |
| 2. Silex, alumine, lime and water. | 11. Silex, magnesia and water. |
| 3. Silex, alumine, alkali and water. | 12. Silex, alumine, manganese, iron and water. |
| 4. Silex, alumine, iron and water. | 13. Silex, alumine, carbon, sulphur and water. |
| 5. Silex, lime, potash and water. | 14. Alumine, silex and water. |
| 6. Silex, barytes, alumine and water. | 15. Silex, alumine, lime, magnesia, carbon and water. |
| 7. Silex, lime, magnesia, iron and water. | 16. Silex, alumine and water. |
| 8. Magnesia and water. | |
| 9. Silex, magnesia, carbonic acid and water. | |

3. Combinations of Earths and Alkalies.

- | | |
|-------------------------------|-------------------------------------|
| 1. Alumine, silex and alkali. | 3. Silex, alumine, lime and alkali. |
| 2. Silex, alumine and alkali. | |

4. Combinations of Earths and Acids.

- | | |
|--|--|
| 1. Alumine, silex and fluoric acid. | 4. Silex, alumine, magnesia and carbonic acid. |
| 2. Silex, alumine, soda and muriatic acid. | |
| 3. Alumine, magnesia and chromic acid. | |

5. Combinations of Earths and Metallic Oxides.

- | | |
|-----------------------------------|------------------------------------|
| 1. Alumine, zinc and iron. | 6. Silex, alumine and iron. |
| 2. Alumine, magnesia and iron. | 7. Silex, magnesia and iron. |
| 3. Alumine, silex and iron. | 8. Silex, lime, magnesia and iron. |
| 4. Silex, alumine, lime and iron. | 9. Ytria, silex, cerium and iron. |
| 5. Silex, lime and iron. | |

We perceive, therefore, by the five foregoing divisions, that the earths enter into combination with *water*, or with each other; with *alkalies*, with *acids*, and with *metallic oxides*, and thus constituting a variety of minerals or stones, from the simple gravel of the ocean, to the most valuable gems or precious stones; and that these species and their varieties, are occasioned by the proportions of the ingredients contained in them; and which, according to the foregoing arrangement, consists of 39 different combinations, whose generic names are applied, or rather, are derived from the predominant ingredient which is first named in the combination. Hence, we have 28 combinations in which *silex* is the predominant ingredient; these are, therefore, *siliceous earths or stones*, properly so called. Again, we have 6 more combinations in which *silex* is an essential and important ingredient; thus, it is either a principle or essential constituent in 34 of the 39 combinations.

Of aluminous earths we have but one *genus*, whose species are composed of *alumine*, nearly or entirely pure, and this is *SAPPHIRE* with its varieties, which increases the list to 40; and of the foregoing 39 combinations, *alumine* is found to be a predominant ingredient in 8 of them; which, added to the *sapphire*, gives us 9 *aluminous earths or stones* out of 40. The earth *magnesia* occurs but once as a predominant ingredient in *hydrate of magnesia*; the earth *zirconia* once, and the earth *yttria* once; thus completing the 40 combinations.

The earths *yttria*, *zircon* and *glucine*, are found to have occurred but in one or two minerals; and the earth *thorina* but once in combination with *yttria*. The former, "from the experiments of Professor BERZELIUS in 1815, has been pronounced to be a *new earth* differing from alumine, glucine, yttria and zirconia." (HENRY.) My impression, with regard to these new earths, is, that they are the product of the peculiar changes or decompositions that have taken place in certain of the foregoing minerals, by a series of fortuitous occurrences, and upon the same principle that *alumine* has been supposed to have derived its origin from *silex*, (page 84.)

XXXI.

Alkaline Earths.

The alkaline earths are, 1. *Barytes*. 2. *Strontites*. 3. *Lime*. 4. *Magnesia*; and because of the *potash* usually found in its composition, 5. *Alumine*. Combinations of these earths with acids, result in the formation of *barytic*, *strontian*, *calcareous*, *magnesian* and *aluminous salts*, viz. 1. Carbonate of BARYTES. 2. Sulphate of barytes. 3. Carbonate. 4. Sulphate of STRONTIAN. 5. Barystrontianite. 6. Carbonate. 7. Phosphate. 8. Fluuate. 9. Sulphate. 10. Arseniate. 11. Tungstate. 12. Nitrate of LIME. 13. Carbonate. 14. Sulphate. 15. Borate. 16. Nitrate of MAGNESIA. 17. Mellate. 18. Sub-sulphate. 19. Phosphate of ALUMINE.

The result of the foregoing combinations give us 95 species and varieties of native mineral salts, formed by the union of alkaline earths with acids. Of these there are two species of *barytic salts*, 3 of strontian, 83 species and varieties of lime, 4 of magnesia, and 3 of alumine. The richest marbles in the universe are contained in this section.

XXXII.

Alkaline Salts with Earthy Bases.

This order, as far as has been yet ascertained, consists of 6 species, formed by combinations of *alumine*, *potash*, *sulphuric acid*, and 1 of *silex*. These are, 1. Sub-sulphate of alumine and potash. 2. Siliceous sub-sulphate of alumine and potash, or *alum stone*. 3. Sulphate of alumine and potash, or *native alum*. 4. *Fluuate of soda and alumine*. 5.

Glauberite. And 6. *Polyhalite*. From the foregoing abridged account of the minerals named in this and the preceding section, it has been shown, that the five genera of alkaline earths, by combining with different acids, have resulted in the formation of 101 *species* of native salts, and embracing among them many compounds of great value, and of importance to the arts, commerce and agriculture, besides several of considerable use in the practice of medicine.

XXXIII.

Combustibles.

Chemically considered, nearly all the bodies in the three kingdoms of nature, are either supporters of combustion, or are combustibles. To enumerate these, would be to retrace nearly all the substances connected with nature. In the present section, it is designed to notice those only, that, according to their physical characters, are strictly entitled to the term combustibles; these are,

- | | |
|--------------|--------------|
| 1. Hydrogen. | 5. Graphite. |
| 2. Sulphur. | 6. Lignite. |
| 3. Carbon. | 7. Peat. |
| 4. Bitumen. | |

This order, besides the seven species just enumerated, consists of 34 sub-species and varieties, in all 41 members, embracing the inflammable gases, the extensive beds of coal, amber, petroleum, &c. &c. I have long since adopted the opinion, that as *oxygen* existed in a latent form in most substances of our globe, and being always accompanied by its antagonist *nitrogen*, with few, if any exceptions; that consequently, all substances influenced by atmospheric air, must contain a proportion of *nitrogen*, as well as *oxygen*; that some substances having stronger affinities for nitrogen than they have for oxygen, enter readily into combination with the latter; an example of which is offered in *cannel coal*, also in *slaty coal*.

Nothing can afford stronger proofs of the imperfect methods of conducting the analysis of substances, than the variable results given by chemists of different specimens of the same compound. Thus, *cannel coal* was found by MR. KIRWAN, to be composed of *carbon* 75.2, *bitumen* 21.68, *ashes* 3.12=99.82 (loss, 0.18.) MR. THOMSON obtained from

a specimen of *cannel-coal* analysed by him, *carbon* 64.7, *hydrogen* 21.6, *nitrogen* 13.7= \rightarrow 100. Again, in a specimen of *slaty coal*, he obtained *carbon* 75.3, *hydrogen* 4.2, *nitrogen* 15.9, *oxygen* 4.6= \rightarrow 100. Indeed, in numerous instances of the analysis of different substances, we find, out of every hundred, a loss of from 1 to 5 per cent., which is not accounted for, (page 72.) The method adopted by Mr. THOMSON in the analysis of these specimens, has given results highly important to the science of chemistry, and has proved, that notwithstanding the great difficulty that attends the analysis of *nitrogen gas*, it is possible, at least, to detect its presence, and to ascertain its volume, when combined with other substances. And we may anticipate the period, when it will be proved both by *synthesis* and *analysis*, that bodies acquire solidity from a given predominance of the *alkalinizing* and solidifying agent of nature, above the *acidifying* and *liquifying* agent; or, in other words, NITRO-FRIGORIC predominating above OXI-CALORIC, as defined in Diagram 1st.

XXXIV.

Ores.

The substances embraced by this class, comprehends all the mineral bodies that are composed either entirely of metals, or of which metals constitute the most considerable and important part. It is from minerals of the foregoing description, that all metals are extracted; for which reason, they have obtained the name of ores. The metals exist in these in one or other of the following states: 1. In a metallic state, and either solitary or combined with other metals. 2. Combined with sulphur. 3. In the state of oxides. 4. In the state of chlorides; or 5. Combined with acids, and thus constituting metallic salts. According to the states in which these metals exist in their ores, will be their genera. The five states above enumerated, are such as they have been found naturally to present, and thus constituting the five following genera:

- | | |
|----------------|---------------|
| 1. Alloys. | 4. Chlorides. |
| 2. Sulphurets. | 5. Salts. |
| 3. Oxides. | |

It must be observed, however, that every metal has not hitherto been found in all these five states, and that some of

them are hardly susceptible of them all. Some orders, therefore, want one or more genera; and this will appear more clearly when the nature of their combinations are investigated. Several of the metals exist only in the state of alloys; hence, such orders can consist of but one genera; such, for instance, are *gold, platinum, palladium, iridium, tellurium, selenium, cadmium, &c.* Other orders, besides existing as *alloys*, also enter into combination with sulphur; hence, constituting *sulphurets*, or with some *oxidizing* body thus constituting oxides; with oxymuriatic acid, or *chlorine* constituting *chlorides*, or with *oxygen*, and thus constituting *salts*. Such orders, therefore, may contain two or more genera, in proportion to the nature of their combinations; and as thirty metals are, at present, acknowledged in the latest works on mineralogy and chemistry, they therefore constitute as many orders in the classification of ores.

The names that have been given to these ores, it will be seen, are derived from the metal most predominant in them, which are as follows:

Orders.

1. Gold.	7. Copper.	13. Cobalt.	19. Chrome.	25. Cerium.
2. Platinum.	8. Iron.	14. Manganese.	20. Molybdena.	26. Selenium.
3. Iridium.	9. Lead.	15. Arsenic.	21. Tungsten.	27. Cadmium.
4. Palladium.	10. Tin.	16. Bismuth.	22. Titanium.	28. Osmium.
5. Silver.	11. Zinc.	17. Antimony.	23. Uranium.	29. Rhodium.
6. Mercury.	12. Nickel.	18. Tellurium.	24. Columbium.	30. Wodanium.

Two hundred and fifty-six species and varieties of the foregoing orders, are enumerated in the last catalogue of metallic combinations, including such only as have been found native in different parts of the globe, as may be seen on consulting THOMSON'S splendid volumes of chemistry, or CLEAVELAND'S scientific arrangement of minerals, &c.

It must be therefore obvious, from the very nature of these combinations, and the amazing number of recent discoveries in the mineral kingdom, that there has been, not only a continued succession of primitive bases, or generic sources, since the Creation, but also an extensive increase in the respective classes and orders of those bodies which constitute it. And we shall shortly discover, in the succeeding sections, numerous circumstances connected with the formation of the different classes of rocks of which the nucleus of our earth is composed, that confirms this opinion. Indeed, we know of

no more ample illustration of this subject, than the palpable and undeniable evidences that these natural formations afford. It actually appears as if nature, designing to be her own historiographer, had written or imprinted in the most legible characters, her origin, her mutations, and her continued increase of subjects, constituting as many epochs; each of which have been, and still are to be decyphered, by an attentive examination of her rocks.

It was from such an examination that the celebrated WERNER qualified himself for instructing his pupils, and for bestowing to the world the most scientific and lucid theory of the earth, that had ever been taught or published; and which has happily rendered the science of geology not only consistent and attainable; but respectable and important; and which has since enlisted the talents of a CUVIER, a JAMESON, a MITCHILL, a CLEAVELAND, and a ROBINSON,* whose splendid works on geology and mineralogy, will secure to them a character and a fame, that entitle them to class among the first philosophers of the present century.

XXXV.

WERNER'S *Arrangement of Primitive Rocks.*

From the most critical examination of the various classes of rocks that have been hitherto discovered, the learned WERNER, Professor of Mineralogy at *Freybourg*, had ascertained such established peculiarities, as enabled him to decide on the difference of their formations, and thence to arrange them in appropriate classes; of which, he enumerates five sets or grand classes.

His first class, which he has termed *primitive formations*, consist of such rocks as do not contain remains of organized

* The literary world are called upon to deplore the lamented death of DR. SAMUEL ROBINSON, of _____, member of the American Geological Society, and author of "A Catalogue of American Minerals, with their localities," &c. This devoted servant of science, was busily engaged in preparing for the press a Theory of the Earth, though labouring under that most distressing and fatal disease, *phthisis pulmonalis*; and for the relief of which he had recently located himself in St. Augustine, where he had commenced a literary correspondence with the author of these sketches; and so intent was this friend to science upon the subject of his pursuits, that he exerted himself to pen his last letter to the author, but a few hours before his dissolution. The loss of such a character is a national one; his invaluable works will be his best eulogium.

bodies, or any extraneous matter indicative of the previous existence of either vegetable or animal life. Hence, it is conceived, that these rocks were formed before the earth was fertilized by vegetables, or inhabited by animals. Further, the rocky masses that now exist, amount to about sixty different combinations or formations; of these, variously placed over each other, the whole crust of the earth is composed to the greatest depth that the industry of man has been able to penetrate. Now, these rocks, with respect to each other, occupy a *determinate situation*, which holds *invariably* in every part of the earth. Thus, *limestone* is no where found under *granite*, but always above it. It is to be noticed, however, that *primitive granite* is meant, because, WERNER has since discovered a newer formation of that mineral bedded upon *newer porphyry*, and under *newer serpentine*, and this rock is consequently distinguished as *transition granite*.

Were we to suppose every particular rock or layer which constitutes a part of the earth's surface, to be extended round the whole earth, and to be wrapped around the central nucleus like the coats of an onion; in that case, every rock would occupy a determinate place; one species would be always lowest, or nearest the centre; another species would uniformly rest upon the first, a third upon the second, and so on. Though the rocks do not, in reality, extend round the earth in this uninterrupted manner, though partly from the irregularity of the *nucleus* on which they rest, partly from their own irregularity of thickness in different places, and partly from other causes, the continuity is often interrupted; yet still, we can trace enough of it to convince us, that the rocks which constitute the earth's crust, considered in a great scale, are every where the same, and that they occupy the same situation with respect to each other. WERNER has therefore chosen the *relative situation* as the basis of his classification of rocks. In particularizing these classes, the first consists of those rocks that lie nearest the centre of the earth, and are covered by all the rocks we know; hence it is the lowest. The second class consists of those rocks, which, in that case, would lie immediately above the first class, and cover them. The third would cover the second in the same manner; the fourth the third; and the fifth would be uppermost of all, and constitute the immediate surface of the earth.

The first class of rocks are covered by all the rest; but, never themselves lie over any other. These grand classes of rocks he has denominated formations, and distinguishes them by the following specific names:

Class 1. Primitive formations.

2. Transition.

3. Floetz.

4. Alluvial.

5. Volcanic.

It is to be remarked, that the *primitive formations* are not always at a great depth under the surface; very often they are at the surface, and constitute mountains. In like manner, the *transition* and other formations may, each in their turn, occupy the surface and constitute the mass of a rock or mountain. In such cases, it must be evident, that all the subsequent formations which would otherwise cover them, are wanting in that particular spot. Each of these grand classes of formations, consists of a greater or smaller number of rocks, which occupy a *determinate position* with respect to each other; and which, like the grand formations themselves, may often be wanting in particular places. WERNER enumerates fifteen sets of rocks in his first class; seven sets of which are *actually primitive*. Thus, 1. Granite, lowest of all the rocks. 2. Gneiss, covering granite. 3. Mica slate, over gneiss. 4. Clay slate over mica slate. 5. Newest primitive porphyry over clay slate. 6. Sienite over the porphyry. And 7. Newer serpentine over sienite. The eight remaining rocks of this class, he terms subordinate. (See THOMSON, JAMESON, CLEAVELAND, &c.)

His second class consists of such rocks as have imbedded in them such fossil remains as are not known to exist in the present age of the world, and consist of the extinct species of *coral* and *zoophytes* towards their summits; and of vegetable petrifications of extinct species of *ferns*, *capillary plants*, and palm leaves towards their base. This remarkable circumstance induced him to conclude, that these rocks were formed after the earth contained *organic beings*. Hence, the name *transition*, which he has imposed upon this class, as if they had been formed when the earth was passing from an uninhabited to an inhabited state. The date of these formations is considered to be very remote, since the petrifications which

they contain are the remains of vegetable and animal species now extinct.

All the rocks of this class do not afford petrifications: since, according to JAMESON, these bodies have been discovered hitherto only in the *limestone*, *greywacke*, *greywacke slate* and *clay slate*.

The third grand class of formations has received the name of *floetz* or *flats*, because they lie usually in beds much more nearly horizontal than the preceding. They contain abundance of petrifications, and these much more various in their nature, than those which occur in the transition formations, consisting of *shells*, *fish*, *plants*, &c. indicating that they were formed at a period when these organized bodies abounded.

The fourth grand class is termed *alluvial*, and constitutes the great mass of the earth's surface; it is thus termed, because this class is formed by the gradual action of rain and river water upon the other formations; and may be considered as very recent formations, or rather deposits; the formation of which is still going on. Alluvial formations are generally divided into two sets, or those deposited in the vallies of mountainous districts, or the elevated plains which often occur in mountains, and those deposited upon *low flat land*. The first kind consists of sand, gravel, &c. which constituted the more solid parts of the neighbouring mountains, and which remained when the less solid parts were washed away. The second set consists of *loam*, *clay*, *sand*, *turf* and *calc tuff*, which latter is a chemical deposite, extends widely, and contains plants, roots, bones, &c. which it has encrusted. The clay and sand often contain petrified wood, and likewise skeletons of quadrupeds.

To Professors CUVIER, MITCHILL, JAMESON, &c. we are particularly indebted for the discovery and detail of the most important geological facts concerning the organic depositions contained in the different formations of the globe; and in order to distinguish these deposits, with a view to the establishment of the respective periods of their deposition, I have embraced the following method, which is, in fact, an abridgment of the important details of the foregoing illustrious philosophers on this subject.

XXXVI.

Of Primitive Petrifications.

That petrifications naturally divide themselves into two kinds, is readily inferred from what has been already said concerning them. The *first* consists of the extinct species of vegetables and of marine animals, such as *madrepores*, *corals*, &c.; and the *second* of both marine and land animals, whose species are extinct or unknown to the present age, and consisting of *amphibia*, *quadrupeds* and *human skeletons*.

Those are to be considered the most ancient, and consequently of the *first class* of primitive petrifications, that are found in situations that appear to have been forming; and these remains to have been deposited in them while thus forming, and, anterior to the earth's being inhabited by land animals, or animals of the more perfect species.

The first class of primitive petrifications, therefore, appear to consist of *fossil corallitic* and other marine substances, that have been discovered imbedded in the *transition rocks*, in various parts of the globe, together with plants of the capillary species, such as *ferns*, *maiden hair*, *spleenwort* and leaves of *palm trees*. JUSSIEU, in his dissertation on the herbs, sea shells, and other bodies, found in certain stones at *Chaumont* in the province of *Lyons*, mentions the impressions of various kinds of herbs upon these stones, which he describes to be of the species of *ferns* and *palm trees*. DE MAILLET, in his *Telliamed*, describes the same impressions, and tells us, that "the multitude of the difference of these plants is so great about *St. Chaumont*, that every quarry seems to be a source of incredible variety." WERNER, in his general observations on the formation of rocks in the district of *Freybourg*, describes similar impressions in the rocks of his second or transition class, in which the vegetable petrifications are alledged to be "the fruit, stems and leaves of palm-like vegetables and parts of reeds."

JAMESON, in his notes on CUVIER's Essay, speaking of the distribution of petrifications, says, "that in the coal beds of the first floetz limestone, the vegetable impressions are of *lycopodiums* and *ferns*, resembling those found in the old coal formation. But, that besides these, are the remains of plants of the palm tribe;" &c. MR. WEBSTER, in his remarks on the mineralo-

gy of the south of England, describes the fruit, branches, excrescences, ligneous seed vessels, and berries impregnated with *pyrites*, as occurring in the lower marine formation above the chalk, in England. PROFESSOR MITCHILL, in his observations on the geology of North America, describes a strata of argillaceous slate, found near *Wilkesbeare* in Pennsylvania, that contains numerous impressions of *ferns* and other capillary plants, and the bark of palm trees.

Madreporites, tubiporites, milleporites, and a vast number of the different genera and species of fossil marine relicks, shells, &c. have been discovered imbedded in transition limestone rocks, in *greywacke*, *clay slate* and *greywacke slate*, and other formations anterior to the *alluvial*; which prove, beyond controversy, their claims to the rank of primitive petrifications. And they are so widely and extensively distributed in all parts of the globe, and in the same, or nearly the same geological situations, as further to prove, that they have been deposited contemporaneously, or at the same periods of time, in all those parts of the earth in which they have been detected. I have been informed, that in *Edgefield* and *Lexington* districts in South-Carolina, valuable *whet-stones* have been found in abundance; and that certain bodies, in a perfectly mineralized state, and completely petrified, yet resembling various fruit, are also frequently found in the same districts.

XXXVII.

Second Class of Primitive Petrifications.

The second class of primitive petrifications, consist of those fossil organic remains of bodies whose generations are extinct, or of which no living traces have been discovered in any part of the globe. It may be worthy of remark in this place, that specimens of fossil organic remains of the same species, taken from different sections of the globe, or from different strata of the same sections of the globe, are, some more perfectly mineralized than others, and this circumstance might seem to operate against the conclusion of their being deposites of the same period or date. The more perfectly mineralized specimens being considered the most ancient, while those that have been imperfectly mineralized, as the fossil bones dug up at Biggin Swamp in the Santee Canal, that appear to be only bleached or calcined, as it were, might

be considered as more recent deposits, than those vestiges of the same species that have been found in other parts of the globe, and in more perfect states of petrification. This difference is easily accounted for by adverting to the fact, that it depends wholly upon the *petrifactive* or *non-petrifactive* properties of the *stratum* in which these remains are imbedded. Those found in gypsum or calc-tuff beds, are consequently saturated with the *siliceous* or *calcareous* particles which constitute the *stratum*, and become hence perfectly mineralized; while those found in simple alluvial soil, peats, or bogs, are necessarily less perfectly petrified, and are soon decomposed on exposure to the air.*

The fossil organic remains which constitute this second class of primitive petrifications, are, some of them, so extraordinary, as to appear to us almost, the assertions of men labouring under the influence of a disordered imagination. I shall, therefore, waive the insertion, at least, in these synoptical sketches, of those extraordinary remains, referring the inquisitive reader to the writings of M. DE MAILLET, who appears to have extended his researches to the utmost limits of authentic ancient history, for the wonderful facts recorded in his *Telliamed*, or *World Explained*, and shall attend exclusively to those discoveries that have been made in our own times, and in some degree, within our own personal recognition.

To CUVIER's Essay on the Theory of the Earth, the following important geological discoveries have been appended by Professor JAMESON of Edinburgh, in his valuable notes on the said essay. These notes contain a condensed view of the fossil organic remains described by that indefatigable geologist, and consist of numerous extinct species of *quadrupeds*, *amphibia*, *fishes*, &c. discovered in the limestone caves and gypsum beds of Germany, Hungary, Bohemia, France, *Cette*, Gibraltar, Nice, Antibes, Corsica, Dalmatia, the Island of Cerigo, Arragon, and in the Vicentine and Veronese. They include many genera and species of quadrupeds, nearly allied to the presently existing species; but are, nevertheless, decidedly of distinct classes to any now existing. In Germany

* The waters of Edisto River in South-Carolina, are becoming famous for mineralizing the boughs of trees; a specimen of which is in possession of Mr. Blewer, on the King-street Road.

and Hungary, the fossil remains of two species of bears, are abundant in the limestone caves; and what is remarkable, they occur in an extent of upwards 200 leagues!

ESPER describes a prodigious quantity of teeth, jaws and other bones, discovered grouped with stalactites in the caves of *Gaylenreuth* on the frontiers of *Bayrenth*, where hundreds of cart-loads of bony remains have been found; three-fourths of which, CUVIER estimates to be those of bears now extinct; one half, or two-thirds of the remaining fourth, belong to a species of *hyæna*; a small number belong to the *lion* or *tiger* genus; another portion to animals of the *dog* or *wolf* kind; and lastly, the smallest portion to different species of smaller carnivorous animals, as the fox and pole-cat.

The limits of this synopsis, will not admit a detailed account of these remains; I shall, therefore, briefly enumerate their classes, orders, families and species.

Class 1. Mammalia; order, *digitata*; family, *glires*; of this family, a species of *cavia*, nearly allied to the guinea pig, and a species of *mus*, allied to the earth rat.

Of the family *feræ*, two species of *ursus* or bears; quantity incredible.

Of the genus *canis* or dog, several species.

Of the genus *felis* or cat, one species allied to the *iaugar*.

Of the genus *viverra* or weasel, two species allied to the pole-cat.

Of the family *bruta*; genus, *bradypus* or sloth, two species.

1. *Megalonix*, the size of an ox, discovered in the limestone cave of Virginia. 2. *Megatherium*, of the size of the *rhinoceros*, discovered at *Buenos Ayres*.

Order *Marsupialia*; family, *didelphis*, one species.

Solidungula; genus, *equus* or horse, one species.

Bisulca; genus, *cervus* or deer, seven species. 1.

Fossil elk of Ireland. 2. Fossil deer of Scania.

3. Of *Somme*. 4. Of *Etampes*. 5. Fossil roe

of Orleans. 6. Of *Somme*. 7. Fossil red deer

or stag.

Genus *bos* or ox, four species. 1. Aurochs. 2.

Common ox. 3. Large buffalo of Siberia. 4.

Fossil ox, resembling the musk ox of America.

Order *Multungula*; genus *rhinoceros*, one species.

Genus *hippopotamus*, two species.

Genus *tapir*, two species.

Elephant or mammoth of the Russians, one species.

Genus *sus* or hog, one species.

Genus *mastodon*, five species. 1. The great mastodon. 2. Mastodon with narrow grinders. 3. Little mastodon with small grinders. 4. Mastodon of the cordilleras. 5. Humboldtian mastodon.

Genus *pulcotherium*, ten species, varying in size, from that of a horse to that of a common sheep.

Genus *anoplotherium*, five species, of similar sizes with the foregoing.

Order *Palmata*; family, *glires*; genus, *castor* or beaver, two species.

Family, *feræ*; genus, *phoca* or seal, one species.

Family, *bruta*; genus, *lamantin*, two species.

Class *AVES*. Genus *sturnus* or starling, several species.

Class *Amphibia*; order, reptiles; genus, *testudo* or tortoise, several species.

Genus *crocodilus* or crocodile, two species.

Genus *monitor*, one species.

Genus *salamandra*, one species.

Genus *bufo* or toad, one species.

Class *PISCES*. Various fragments of undetermined species.

With regard to the fossil *saurus* of CUVIER, SOMMERRING has determined it to form one of a series of animals intermediate between the class *mammalia* and the class *aves*, and has named it *ornithocephalus antiquus*, from the resemblance of its head to that of a bird.

All the fossil species of quadrupeds, enumerated above, have been found in the alluvial soil which covers the bottoms of valleys, or is spread over the surface of plains. All of them are strangers to the climate where these bones now rest. The five species of *mastodons* alone may be considered as forming a distinct and hitherto unknown genus, nearly allied to that of the elephant. All the others belong to genera, still existing in the torrid zone. Three of these genera, viz. the *rhinoceros*, *hippopotamus* and *elephant*, occur only in the old world;

the fourth, the *tapir*, exists only in the new world. The fossil species included under the known genera, differ sensibly from the present species, and are certainly not mere varieties. Of all the above fossil species, the large *hippopotamus* is the only one which, we cannot say with certainty, does not belong to the present living species of that genus.

The small hippopotamus and gigantic tapir, are unquestionably new species; there is scarcely a doubt of the fossil rhinoceros being a distinct species; and although the fossil elephant and the little tapir, are not so well marked as new species, yet as CUVIER remarks, there are reasons sufficient to convince the experienced anatomist, of their being different from any of the present existing species. These different fossil bones are found every where in beds of nearly the same kind; they are often promiscuously mixed with bones of animals resembling the species of the present time. These beds are generally alluvial, either sandy or marly, and always near the earth's surface. It is therefore probable, that these bones may have been enveloped by the last, or one of the last catastrophes to which our earth has been subjected. In many places they are accompanied with accumulations of marine animal remains; and in other places, the sand and marl which cover them, contain only fresh-water shells. We have no authentic account of their having been found covered with *floatz* or other solid strata, containing marine animals; and, therefore, cannot affirm that they were, for a long time, covered with a tranquil sea. (JAMESON'S CUVIER.)

XXXVIII.

Proofs of the universality of certain Fossil Organic Remains.

The rocks of *Judea* are, in many places, covered with a soft chalky substance, in which is enclosed a great variety of shells and corals. The greatest part of Mount Carmel, and those of Jerusalem and Bethlehem, are overspread with a white chalky stratum. In Mount Carmel are gathered many stones, which, being in the form of olives, melons, peaches and other fruit, are imposed upon pilgrims, not only as those fruit petrified, but as antidotes against several diseases. (MAUNDREL.)

The mountains and quarries of Europe, afford numerous specimens of primitive petrifications of the first class.

Switzerland is remarkable for the petrifications contained in her mountains and repositories; petrified fish, of various kinds, are found imbedded in them. Mount *Pelaere* in *Lucerne*, supports an entire rock of petrified shells of oceanic origin. There are rocks of this kind in all the large mountains on continents, in the Pyrenean mountains, and those of China and Peru. We find the same disposition in all countries where there are high mountains, though they are more remarkable in some parts than in others. We almost everywhere find upon the declivities of mountains sea shells, madrepores, and corals petrified, and still adhering to the rocks. The mountains of *Pisa* in *Tuscany*, are covered with oyster shells to an extent of two or three miles. *FUEILLE* describes the mountains of Peru as presenting the same phenomenon, which has been also discovered in the country of the *Acutoukas* of *Mississippi*, 450 miles from the sea shore. In *France*, about 60 leagues from *Bordeaux*, in the parish of *St. Croix du Mont*, there is a stratum of stone covered by a bed of oyster shells twenty or twenty-five feet thick, and extending upwards of a hundred fathoms, and is again covered by another formation of stone five or six feet thick. In this, the inhabitants have hewn out a chapel 15 feet high, in which they celebrate mass. The shells are united in the bank by a sand, which, being mixed and petrified with them, at present forms but one common rock. About half a league from *Frankfort*, on the other side of the *Main*, there is a mountain called *Saxenhausen*, whence stones are dug; the whole substance of which is composed of small petrified shells; they are united by a fine sand, which forms a very hard stone, of which the strong walls of that beautiful city are built. At *Vaquine*, a small town in *Provence*, we find another mountain full of sea shells and large oysters, some of which are still alive. The fields adjacent to *Havre de Grasse* are full of oyster shells, which are also to be met with in a great many parts of *France*. (DE MAILLET.)

In the environs of *Paris*, numerous deposits of marine shells have been discovered by *CUVIER*, *BRONGNIART*, and at *Grignon* by *M. DE FRANCE*. In the south of *England*, *Mr. WEBSTER* has ascertained upwards of 80 species, and varieties of marine shells, madrepores, sponges, and numerous unknown zoophytic remains.

In North America, the remains of marine animals in the soil and rocks adjacent to the lakes are numerous. They abound in the greater part of the distance from Lake Erie through the counties of Niagara, Genessee, Ontario, Seneca, Cayuga and Onondago. They exist too in the counties of Lewis, Jefferson, St. Lawrence, Madison, Essex, Oneida, Montgomery, Washington, Chenango, and various others. The rocky stratum in the county of Ontario, is filled with organic remains; these are mostly *madrepores* of fantastic forms, differing from any at present found growing in the ocean. Along the *Illinois*, in its whole course from Chicago near Lake Michigan to the Mississippi, organic remains of *molluscas*, and other unknown animals, are contained in the flinty masses, as noticed by that enterprising officer *Major LONG*, of the corps of Engineers. In the limestone around *St. Louis* and down the *Mississippi* to *St. Genevieve*, and beyond, abundance of *shells* and *madrepores* have been found. *DR. DRAKE* has detected similar organic remains in the limestone surrounding *Cincinnati*; they consist of various species of marine shells, *madrepores* and *tubipores*. In the rocky masses near *Kingsbury* in the state of New-York, in *Cherry Valley*, at *Helleberg*, in *Coeyman's Patent*, and the region watered by the *Walkill*, the quarries of *Kingston*, and various other places in the state, peculiar *madrepores*, *corallines*, and numerous species of marine shells, are abundant. (MITCHILL.)

An extensive stratum of *fossil oyster shells*, has been long known to exist in South-Carolina; they are of a circular form, and of a diameter of seven or eight inches; they are thick and heavy, dissimilar from any shells which are found on our sea shores. They extend from *Nelson's Ferry*, in the upper part of the district of *Charleston*, in a south-westwardly course nearly parallel with the sea, towards the *Three Runs* on *Savannah River*, and are probably connected with those which *MR. BARTRAM* describes as being fifteen miles below *Silver Bluff* on the *Georgia* side. (DRAYTON, RAMSAY.) Various strata of marine shells have been found in digging wells, &c. in the district of *Charleston*. In some places, strata of shells, so agglutinated with marl and sand as to appear like stone, have been discovered at a depth of fifteen feet below the surface of the earth. In *MR. LONG-*

STREET's experiment, that of boring for water, on a lot in *Archdale-street*, marine shells were discovered at a depth of 17 feet below the surface; and again, another stratum at a depth of 49 feet! (RAMSAY.) On boring for water on the square partly occupied by the Poor-House, the commissioners discovered a stratum of marine shells between 18 and 20 feet below the surface; again, another stratum 35 feet; a third stratum 43 to 46 feet below the surface; and lastly, at the amazing depth of 314 feet 3 inches, to 317.2. A stratum of shells, marle, sand and clay, and some thick solid marine shells broken. (MOSER.)

The state of Georgia is said to be very rich in rare *fossil sea shells*. "On the south bank of Savannah River, near the place called *White Bluff*, about a hundred miles on a straight line from the sea shore, the shell banks make their first appearance, and run a course south-west.* These shells occur in different parts of the ridge of the land in which they are imbedded, to a distance of forty miles. According to GENERAL MERIWEATHER, not only the *oyster shell* is found, but *clam shells*, and a *scalloped shell* nearly similar to the clam. The *General* thinks he has seen some of them large enough to contain the foot of a common man. At some distance above this ridge, there are several quarries of a kind of siliceous stone, which has a number of all kinds of shells intermingled and dispersed through it; these are petrified and hard as flint, are wrought into mill stones, and are considered as a good substitute for *French buhrs*. In a spring near the high shoals of Apalachy, are found many *echinites* of a flat form, rather larger than a Spanish dollar; they are converted to flint, and are a species of the *scutella* family. ELLICOT's Journal contains accounts of the limestone rocks and fossils of the *Apalachy*, *Chatahouche* and *Flint Rivers*. It is composed, in many places, of broken shells, and filled with petrifications. In *Alabama*, on the *Tombigbee* River, fossil shells of *bivalve molluscas*, of sea urchins and radiary animals, are found; and fifteen or twenty feet below the surface, is a stratum where wood is found of different kinds, partly decayed. Again, beneath this and a concomitant body of clay and limestone,

* Doubtless these are a continuation of the stratum mentioned in the preceding paragraph.

is a substance resembling the grass of the margin of the ocean, accompanied by numberless marine shells. (MITCHILL.)

XXXIX.

Proofs of the universality of the remains of Extinct Animals.

The soil of *South-Carolina* appears to have been the first in North America, in which the bones of the *great mastodon* have been discovered. MR. CATESBY gives an account of some relics of an animal supposed to be of the elephant species, dug up at *Stono Swamp* as early as the year 1734. And in digging the *Santee Canal* in the year 1795, COLONEL SENE, the engineer, found several bones of this animal between eight and nine feet below the surface of the earth. Again, in 1797, others of a similar kind were discovered, about four miles distant from the first. (DRAYTON, RAMSAY.)

In *Kentucky*, at the *licks*, which from the circumstance of the extraordinary number of bones found at different depths, from one foot to twenty feet below the surface, has received the name of the *Big-bone Licks*. GOVERNOR CLARKE, at the especial request of the venerable MR. JEFFERSON, in 1807, caused the soil to be extensively explored, in which, numerous remains of this animal have been detected, and identified with those of the great American Mammoth. (JEFFERSON, MITCHILL.) In *Indiana*, bones of the same animal were found in July 1817, in the east branch of the *White River*, a stream emptying in the *Wabash*. In *Pennsylvania*, similar remains have been discovered near *Bedford*. In *New-York*, at *Chenango*, at *Goshen*, the region watered by the *Walkill*; in the county of *Rockland*, 30 miles north of the city of *New-York*; and at *New Antrim*, eleven miles west of the latter place, numerous bones, some of the entire animal, of which the one in PEALE's splendid Museum at *Philadelphia*, is an example of the species of this extinct quadruped. On the eastern shore of *Maryland*, the grinder of an elephant was dug up, which, according to DR. HAYDEN, differs from the grinders both of the *African* and *Asiatic* elephants. In the district of *Columbia*, the rib of a very large animal of the elephant species, was dug out of the bank of the *Potomac*. In *Virginia*, in 1811, the remains of a *mammoth* were found on

the bank of York River, about six miles east of Williamsburgh. This discovery was communicated to the public by the venerable President of *William and Mary College*, the Rev. Bishop JAMES MADISON. (MITCHILL.)

As yet, we have no authentic accounts of there having been any discoveries of a similar nature, in either of the remaining states except *Florida*. Fossil remains of the *mammoth*, have been found in that part of Florida now distinguished as the state of *Louisiana*. These bones were found at the *Ope-lousas*, on the farm of M. NERAT; a cart load, or more, were disinterred.

Bones of this animal have been found in many different parts of the island of *Great Britain*; as in the alluvial soil around *London*, in the county of Northampton, at Gloucester, at *Trenton*, near *Stafford*, *Harwich*, *Norwich*, in the island of Sheppy, in the *River Medway*, in *Salisbury Plain*, and in *Flintshire* in *Wales*, and in the north of *Ireland*. (JAMESON.) Bones of this animal have been dug up in *Sweden*; and CUVIER conjectures, that the bones of supposed giants, mentioned by the celebrated Bishop PONTOPPIDAN, as having been found in *Norway*, are the remains of the fossil elephant. TORFÆUS mentions a head and tooth of this animal dug up in the island of *Iceland*.

In *Russia* in *Europe*, in *Poland*, *Germany*, *France*, *Holland* and *Hungary*, teeth and bones of this species of elephant, have been found in abundance. HUMBOLDT found teeth of this animal in North and South America. But it is in *Asiatic Russia* that they occur in greatest abundance. PALLAS says, that from the *Don* or *Tanais*, to *Tchutskoinoss*, there is scarcely a river, the bank of which does not afford remains of the mammoth, and these are frequently imbedded in, or covered with alluvial soil containing marine productions; the bones are generally dispersed, seldom occurring in complete skeletons; and, still more rarely, do we find the fleshy part of the animal preserved. One of the most interesting instances on record, of the preservation of the entire carcass of this animal is given by CUVIER, as taken from a report in the supplement to the *Journal du Nord*, No. XXX, by MR. ADAMS, adjunct member of the academy at St. Petersburg; for an account of which, the reader is politely referred to MITCHILL's edition of JAMESON's CUVIER, p. 253.

XL.

Proofs of the atmospheric origin of AEROLITES or Meteoric Stones.

In my sixth lecture on the principles and properties of the electric fluid, sect. 4, I have devoted much attention to this wonderful and important subject; an abridged view of which I shall give in this section. We have the most respectable authorities for proving, that from time to time, there has fallen from the atmosphere upon the earth, ponderous masses of metallic substances, termed *aerolites* or meteoric stones, some of which have been found to exceed thirty tons, or sixty thousand pounds weight! Occurrences of this kind, though not always to the same extent, have been recorded by MOSES in the Bible, and subsequently by LIVY, PALLAS, PLINY, DION, CARDEN, MUSCHENBROEK, DE LALANDE, FOURCROY, THOMSON, JAMESON, BRANDE, and a host of other eminent philosophers.

The facts most remarkable in these stones, are, that there is nothing like them in the earth, and that their descent to the earth is always preceded by, or accompanied with *meteors* or other aerial phenomena. Almost all the meteors that have been observed, resembled each other in their characters. They were luminous, at a very great height, moved very swiftly, and disappeared in a short time; their disappearance was usually accompanied by a loud explosion like a clap of thunder; and it was always constantly affirmed, that heavy stony bodies fell from them to the earth. Previous to their fall, they move in a direction nearly horizontal, and they seem to approach the earth before they explode, and the explosion is followed by showers of sand, sulphur, &c. or the falling of stones. Sometimes the stones continue luminous till they sink in the earth; but, most commonly, the luminousness disappears at the time of the explosion. They are always hot when they fall, and differ in size from a few ounces to several tons! they are usually roundish, and always covered with a black crust, which, from the analysis of HOWARD, consists chiefly of *oxide of iron*. In many cases they smell strongly of sulphur.

Some of the ancients considered these stones to be of volcanic origin. Others, that they were bodies floating in space

unconnected with any planetary system; that they are attracted by the earth in their progress, and kindled by their rapid motion through the atmosphere. Some again consider them to be little planets, which, circulating in space, fall into the atmosphere, which, by its friction, diminishes the velocity, so that they fall by their weight. LA PLACE suggests the probability of their having been thrown off by the volcanoes of the moon. MR. THOMSON considers them fragments of fire balls. But the most probable opinion of the origin of these *aerial visitants*, appears to me to be that advanced by MR. KING and SIR WILLIAM HAMILTON, "*That they are concretions actually formed in the atmosphere;*" and this conclusion, it is said, has been acceded to by most philosophers. (ANNALS OF PHILOSOPHY, &c.)

I have several reasons for concurring with these gentlemen, and for believing these bodies to be of atmospheric or *electrical origin*. It will be recollected, that my theory of electricity, considers *magnetism* as one of its species. I have already explained, in the preceding sections, the astonishing influence and powers of the great physical agents, and their properties of attraction and repulsion; contraction and cohesion; the polarising or magnetizing powers of the *violet ray*; and the influence of these agents as constituting the ethereal fluids of the firmament. We have only, therefore, to reflect upon the all pervading and all sustaining qualities of these fluids, that innumerable worlds are suspended and kept within their orbits, receive their fuel and their fires, and are made to perform all their revolutions upon *the bosom of this ocean of ethereal fire!* And shall we, for one moment, hesitate to admit its capability of supporting these bodies, of attracting and holding the particles of which they are formed, in perfect chemical combination?

The phenomena that invariably accompany these *aerolitic* substances, have been admitted by the most eminent philosophers to be strictly electrical; that is, the *meteors* from which they proceed, or by which they are accompanied; and when we consider the materials of which these bodies are composed, we can no longer hesitate in yielding to the fact, that they are of electrical origin.

The results of the chemical analysis of these stones by MR. HOWARD, VAUQUELIN and others, afford sufficient proofs

of the correctness of the opinion which I have advocated. These eminent chemists have all agreed as to the constituents of these bodies, which are found to be as follows: 1. *Iron*. 2. *Nickel*. 3. *Chromium*. 4. *Cobalt*. (These are all magnetic metals.) 5. *Oxide of iron*. 6. *Sulphur*. 7. *Silica*. 8. *Manganese*. 9. *Lime*. 10. *Alumina*. 11. *Magnesia*. These constituents are not invariably present in all the specimens that have been analyzed; but are meant to convey an idea of the aggregate result of the various analysis that have been made of them. Some have been found wanting of several of these bodies; while others have been deficient of some others differing from them; but the result of the most remarkable analysis of these stones, is that which has been enumerated above.

In THOMSON'S chemical works, we perceive a table of these stones drawn up by that indefatigable naturalist M. IZARN; from which, 16 have been considered of importance towards the establishment of the fact of their occurrence, and the diversity of their appearance, which will account for the different results of their analysis. The *first* is the *shower of sulphur*, recorded by MOSES in the *XIXth chapter of Genesis*, 24th v. 2. A mass of iron of 14 quintals, noticed by PALLAS, as having fallen at *Abakanh* in *Siberia*. 3. The shower of stones, mentioned by LIVY, which fell at *Rome*, Anno 640 before CHRIST! 4. A similar shower of stones at *Rome* 324 years before CHRIST! recorded by OBSEQUENS. 5. A very large stone which fell near the river *Negos* in *Thrace*, in the 2d year of the 78th *Olympiad*, recorded by PLINY. 6. A stone weighing 255lb., which fell near *Basle at Ensheim*, on Wednesday, the 7th November, 1492, accompanied with loud thunder. This stone was, by order of King MAXIMILLIAN, deposited in the church of *Ensheim*. 7. The fall of 1200 stones in the year 1510, near *Padua* in *Italy*, one of which weighed 120lbs., and recorded by CARDEN and others. 8. A burning stone which fell on *Mount Vaisir* in *Provence*, on the 27th November, 1627, recorded by GASSENDI, which weighed 50lbs. 9. A stone of 300lbs., which fell near *Verona* in the year 1672. 10. A stone which fell at *Larissa*, with a hissing noise and the smell of sulphur, in 1706, recorded by LUCAS. 11. In 1753, DE LELAND witnessed a phenomenon of the same kind near

Pont de Vesle. 12. In 1768, three of these stones fell in different parts of France. 13. In 1783, one of these stones fell in England, and recorded by CAVALLO. 14. In 1790, there was a shower of stones near *Agen*, witnessed by DARCET and others. 15. In December, 1795, a stone fell in Yorkshire, England, near the house of *Major TOPHAM*; it weighed 56lbs. (BRANDE.) 16. A mass of iron, *seventy cubic feet*, fell in America, April 5, 1800, and recorded in the *Philosophical Magazine*; besides various others of smaller dimensions, from 7 to 60lbs., which fell in various parts of the world, together with showers of sand, of fire, of sulphur, and of mercury. (THOMSON, vol. 3, p. 197.) 17. M. DE HUMBOLDT has announced, that an *aerolite* has been found, which is truly a volcanic production, it being formed of crystals of *pyroxene*; but he doubts its having been projected to the earth by a volcano of the moon. The capacity of the gases for holding in solution the particles of matter, and which constitutes a principal feature in my Theory of the Earth, has been somewhat confirmed by the conclusion of SIR H. DAVY's experiments on *ammonia*, which, says HENRY, "If this should be established, we shall obtain proof of a fact of the greatest novelty and curiosity, viz. the existence of a metal, or a *metallic oxide*, whose natural state is that of an *aeriform fluid*." (HENRY, vol. 1, p. 201.)

To the mind prepared to acknowledge the *omnipotent* influence of the SUPREME FIRST CAUSE! and to refer to it, as competent to every possible event and contingency in nature, novel and curious as it might appear, it would convey the idea, that such was probably the primitive state of the primordial mass of matters at the Creation; that is, their "natural state was that of aeriform fluids," holding in solution the base of all bodies, and existing in the condition described in the VIth sect. p. 14. I have also remarked on the influence of the three simple gases, *hydrogen*, *oxygen* and *nitrogen*, as extending to the utmost limits of our atmosphere; and when we take into consideration the magnetizing influence of the violet ray of light, and the magnetic metals that constitute these bodies, it appears to me, that something like a clue to their origin, offers itself from all these peculiar circumstances, when taken in connexion.

My conclusion has therefore been, that upon the same principles that water holds in solution particles of various substances, of minerals, metals, and *metallic oxides*, evidenced in different mineral springs, whose exhalations are continually mixing with the matters of the atmosphere, that these gases, after having been absorbed by water in and upon the earth, may hold in solution particles of decomposed or oxidized metals and minerals, not however as constituent principles, but merely as so many adventitious combinations, which, in their liberation from the earth, they convey into the higher regions of the atmosphere, in which the *oxygen* and *nitrogen* gases, in the act of their renewal, are disengaged from these particles; and these, by virtue of the *electro-magnetic* attraction, are brought readily to combine, and thus to constitute the *nucleus* of these *aerolitic* compounds, which continue to revolve with our atmosphere, and to accumulate similar matters, until disturbed by the causes occasioning their ignition and consequent explosion or projection to the earth; and these causes, I conceive to be, either the spontaneous inflammation of the substances, or their gravitating towards the region of thunder and lightning in the lower strata of the atmosphere, by which they are exploded. And this opinion of their formation in the atmosphere acquires still greater weight, when it is considered that *aqueous vapours* are abundant in the lower regions of the atmosphere, and hold in solution particles of *silex*, *alumine*, &c.; that these vapours may be rarified and converted into *hydrogen*, still holding in solution these particles, which, uniting with those of the metals, become thus *accreted* in the atmosphere, where they may continue increasing in magnitude, and revolve for ages, or until they arrive at those limits, to which by a law of nature they were destined.

Upon this principle we may very rationally account for the showers of sulphur, which have fallen in different parts of the world since that, recorded by MOSES, and the shower of *red dust* which fell at *Gerace* in *Calabria* during a thunder storm. The analysis of this dust proved it to be of the same origin with the meteoric stones. "Its constituents were *silica*, *alumina*, *iron* and *chromium*; mixed with the rain it became black; when exposed to a red heat it effervesced with acids." (*Annals of Philosophy* for January, 1817.) It is highly proba-

ble that this had been a recent formation, in which the *iron* and *chromium* had been cemented by the *silica* and *alumina*; that it had not yet arrived at the necessary degree of compactness and hardness, when it came in the sphere of the influence of lightning, and was thus exploded and precipitated to the earth in the form of red dust. And upon similar principles, we may account for the occurrence of these phenomena in the form of small stones, sand, fire, mercury, &c. From the foregoing considerations I have been induced to conclude, that these bodies are produced by *electro-magnetic attraction*, since no other than magnetic metals have ever been detected in them; and in them only have all the known magnetic metals been found in combination; and this brings me to the consideration of the numerous metals that have been lately discovered and added to the former catalogue.

XLI.

Remarks on the origin and formation of the New Metals.

Within the last half century, at least 17 new metals have been discovered by various chemists; these being added to those previously known, have increased the list to 30, as described, page 90. It is said, that the ancients were acquainted with but 7 or 8 of these. The discovery of so many new metals, naturally involves the following hypothesis: either, that they have always existed in the earth since its first formation, but from the imperfect researches of previous mineralogists had escaped their notice; or, that they have originated at some period subsequent to the Creation, and are new substances resulting from the amalgamation of two or more of the primitive metals. This latter opinion constitutes another of the principles upon which my Theory of the Earth has been founded, and the following reasons have influenced me in its adoption:

1. That some metals are proved to undergo very remarkable changes, either by combining with *oxygen*, or from the application of intense heat.

2. That iron, or metals in which iron is an ingredient, are the only bodies possessing magnetic properties. Hence, *nickel*, *chromium* and *cobalt*, are suspected to have originated from combinations of *iron* with other substances, while in the state of *aerolites* suspended in the atmosphere, in which they

have acquired magnetic properties from the polarising rays of light.

3. That the other new metals have originated in volcanic fusions, or gaseous deposits from the atmosphere, entering into combination with the earthy deposits, &c. which constitute the various genera of ores.

4. That the affinities of some metals for *oxicaloric*, or the solar *oxidizing* rays, to wit, the rays composed of light, heat and electricity, being greater than for those of *nitro frigoric*, or the solar *deoxidizing* rays, to wit, those composed of darkness, cold and magnetism. It is, therefore, probable, that new compounds are produced, or that the bases of new metals are generated.

The metals are said, as far as we know at present, to be simple or elementary bodies, and may be arranged in the class of simple combustibles; and it is acknowledged, that by a sufficient elevation of temperature, it is probable, that they would all be volatilized; for *platinum* itself, which does not melt at a less heat than 170 deg. of WEDGWOOD, has been observed to boil, when placed in the focus of a powerful burning lens. (*Annals de Chimie*, lix. 92.) It may be proper to call our attention to an important chemical fact in this place; that by "the agency of electricity, the celebrated VAN MARUM subdued to its laws, this hitherto unyielding metal; and it has since been converted into two oxides, by combining with two portions of *oxygen*, by the medium of *galvanic electricity*, and the results are a *protoxide* and *peroxide* of *platinum*." (THOMSON.)

It is evident, from the foregoing remarks, that some metals are more volatile than some others; and others again possess certain physical properties that appear to be peculiar to their order alone. Thus, the *ores of iron* differ from all others, in possessing the greatest possible affinity for *magnetism*. The more precious metals have been found to possess the property of being the best conductors of electricity and heat. Some are easily decomposed or *oxidized* by simple exposure to the atmosphere; others require the agency of heat; while others again resist the greatest artificial heat that the furnace is capable of affording; but at last yield to electro-galvanic influence, to the compound blow-pipe, or to that of a powerful burning lens. Of this latter character, are *platinum*, *tung-*

sten, molybdenum, uranium, titanium, &c. *Platinum* possesses also the property of *welting*, which belongs to no other metal but this and iron. When alloyed with gold and silver, *platinum* is thus rendered soluble in *nitric acid*; and, according to Dr. COOPER, when alloyed with *zinc* and copper, without being thus alloyed, it is not acted upon by any other acid than the *nitro-muriatic* and *oxy-muriatic*. (HENRY.)

We have seen, that four metals are found in meteoric stones, viz, *iron, nickel, chromium* and *cobalt*—that *oxides* of *iron* and of *manganese*, are also present in them; in short, that no other metals than such as have powerful affinities for magnetism, have ever been detected in them. It is, therefore, very natural to conclude, that as all metals are capable of being volatilized, and of becoming *gaseous* under particular circumstances, that the magnetic metals above described, are, by the laws of magnetic attraction, retained in the atmosphere; while those that are not possessed of this property are repelled, and again precipitated to the earth, through whose pores they penetrate to the spot destined for their deposit and subsequent formation; and there appears to remain but little doubt, that all the new metals are but so many products of the old, resulting from the oxidation or volatilization of two or more of these, which, entering in combination form an entirely new compound. In the *Journal de Pharmacie*, for May, 1825, it will be seen, that M. DE HUMBOLDT has presented to the Academy of Sciences, a specimen of *platina*, obtained from the auriferous sands of the *Uralian Mountains*, and observes, that *osmium, palladium* and *iridium*, are found in these sands; and that these three metals have for a *gangue* (or matrix) volcanic substances.

That these new metals are rare, that they are not abundant, and that they possess properties different from those of the old, are but so many arguments in favour of my position, and is a further proof, that these associations or combinations are neither constant, frequent, nor abundant; indeed, some of these substances that have been denominated metals, for instance, *selenium*, is a very imperfect conductor of *caloric*, and is a non-conductor of electricity; two properties that have been considered essential to the character of metals. But, “BERZELIUS is still of opinion, from a review of its other properties, that it is fully entitled to be considered as a metal.

and that its proper place is among the acidifiable metals near to arsenic." (*Annals de Chim. et Phys.* vii. 199. THOMSON'S ANNALS, &c.)

The metals are arranged in four classes by DR. THOMSON. The first comprehending *malleable metals*, which are 14 in number, viz. *gold, platinum, silver, mercury, palladium, rhodium, iridium, osmium, copper, iron, nickel, tin, lead* and *zinc*. The second class includes the *brittle and easily fused*, viz. *bismuth, antimony, tellurium, selenium* and *arsenic*. The third class, metals that are *brittle and difficultly fused*; these are *cobalt, manganese, chrome, molybdena, uranium* and *tungsten*. The fourth class are called *refractory metals*, because they have never yet been exhibited in a perfectly metallic form, but always in combination with more or less *oxygen*; these *titanium,* columbium* and *cerium*. (THOMSON, HENRY.)

Two new metals, *cadmium* and *wodanium*, (page 90) have been added to the list since the publication of THOMSON'S System; and the third, termed *sirium*, supposed to be a metal, but which has since been ascertained to be merely a compound of *sulphur, iron, nickel* and *arsenic*. (HENRY'S *addenda*.) It appears to me, that there is an intimate connection between *iron, nickel* and *platinum*; in fact, that *nickel* is a more perfect state of *iron*, and that *platinum* is the most perfect state to which iron has been, as yet, advanced by nature in her wonderful processes in the atmosphere and earth. It is said, an alloy of iron and nickel has been found in all the meteoric stones that have hitherto been analyzed, however remote from each other the parts of the world in which they have fallen. In these it forms from $1\frac{1}{2}$ to 17 per cent. of their weight. It enters also into the composition of the large masses of native iron, discovered in Siberia and in South America. The truth or fallacy of the opinion which I

* In the year 1798, during an excursion to the sea coasts of the southern extremity of Georgia, I discovered on the south-west end of *Jekyl Island*, an immense quantity of black shining particles, mingled with, or rather strewed on the sea beach. I collected a considerable quantity of this mineral, which I suspected to contain metal. Some years since, I have learnt, that a similar deposit has been discovered on *Sullivan's Island*, and is pronounced to be the *ferruginous oxide of titanium*, and possessing magnetic properties. It is supposed to proceed from granitic decomposition, rolled ashore by the waves of the ocean.

have formed on this subject, remains yet to be investigated. I believe the view to be a new one; and as it is both plausible and rational, I cheerfully submit it to the consideration of the liberal and experienced practical chemist, conscious, that whatever may be the result of their patient investigation, they will award to me at least, the merit of an earnest and truly honest desire, of advancing the science of my native country, to a level with that of the most favoured countries in the world, by a rigid attention to, and an unwearied investigation of, the laws of nature, that are hourly developed in her numerous and correctly defined phenomena.

XLII.

Sketch of a Theory of the Earth.

The principal features of the present Theory of the Earth, differ from former theories, 1. By uniting the most natural principles that have been advocated both by the *Neptunites* or *WERNERIANs*, and *Vulcanists* or *HUTTONIANs*. 2. In the establishment of two great Physical Agents; and, 3. In attempting to establish the fact of the universal influence of the Deluge. There are other features, of minor consideration, however, that have been frequently hinted at in the preceding sections, that may tend in some measure to confirm the present theory; and will therefore, as occasion may require, be again referred to, or brought forward in its support.

Two popular opinions with respect to the original formation of our globe, have obtained each, an extensive celebrity in the literary world, the *WERNERIAN*, which considers *water* to have been the great agent for the formation of our globe; and the *HUTTONIAN*, which considers *fire* to be the agent. These theories separately considered, are unquestionably incomplete; as neither of these agents, nor of both combined, are capable of effecting all the phenomena of creation. That theory therefore which admits of but one agent for the production of all the effects or phenomena of nature, must of necessity be inconclusive and unsatisfactory; when, however, the principles of both are united, they approach nearer to perfection, by affording more rational inferences and conclusions, than their separate investigations could possibly admit.

Every phenomenon in nature, every species of body, whether *gaseous*, liquid, or solid, afford the most satisfactory evi-

dence of the existence and influence of two or more physical agents; and we have seen, that the most experienced philosophers have at last arrived at this conclusion, (page 10) and have denominated *caloric* one of these agents: leaving its antagonist to be considered a negative quality, or substance, caused by the mere abstraction, or absence of their agent *caloric*.

The first step, therefore, towards the establishment of the present theory, is to prove the existence and universal influence of *two physical agents*, possessed of powers adequate, or competent to the performance of all the processes of nature, and containing within themselves the delegated, and hence inherent principles of qualifying their influences to every contingency in nature, but are, at the same time, subject to the laws impressed upon nature by the CREATOR, and by which laws, all her operations are directed and controlled.

The proofs of the existence and influence of two such agents, have been advanced and supported in the preceding paragraphs, and it has been observed of them, that being ethereal and imponderable fluids we have no other method of ascertaining their existence or their influence, than such as are made evident to our senses of sight and feeling; in the development of the various phenomena resulting from their influence; and their number is defined by the constant and invariable effects that are produced by them in and upon all the substances of nature, and these effects are evidenced by the following phenomena, which though variously defined, at last terminate in the conclusion; that there are "two forces to which all the bodies of nature are subject, the expansive and the contractive."

A moment's serious reflection must result in the conclusion, that the cause, which effects the *expansion* of bodies, cannot be the same, that effects their *contraction*; that these adverse effects must depend upon causes antagonist to each other, and that hence, as *caloric* has been ascertained and admitted to be the cause of *expansion*; it cannot, according to *Axiom* vii. p. 8, be also the cause of *contraction*. This, I am well aware, is the conclusion to which every philosopher investigating this subject, arrives; but the difficulty consists in not being able to detect the principle of cold; it is hence considered to be *nothing positive*; and a phenomenon resulting from the abstraction or diminution of heat. This subject having been already

discussed in sections xiv., xv. and xvi., I refer the reader to these, and proceed to notice the phenomena which establish the existence of two antagonist physical agents in the universe, and these are distinguished in works of science as follows:

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|---------------------------|-----------------------------|
| 1. Darkness—Light. | 6. Attraction—Repulsion. |
| 2. Action—Re-action. | 7. Impulse—Resistance. |
| 3. Cold—Heat. | 8. Centripetal—Centrifugal. |
| 4. Expansion—Contraction. | 9. Motion—Rest. |
| 5. Fluidity—Solidity. | 10. Ebbing—Flowing, &c. |

These and various other terms of philosophy and of science, investigate them in every possible way, must at last be brought to the only correct conclusion; that they are all the effect of *two opposite forces*, or primary physical causes in nature; and hence, these terms are only so many synonymes of the primitive terms of *action* and *re-action* in all the movable matters of nature, or as Professor O'GALLAGHER and Sir RICHARD PHILLIPS observe, the *pressure* and *resistance* of one body against its antagonist. Indeed, the agency of two antagonist powers, has been acknowledged by eminent physiologists as influencing the human or animal economy. The celebrated MAGENDIE, CHAPMAN, and others, according to PARIS, in his *Pharmacologia*, p. 116, considers the blood-vessels and absorbents as antagonist to each other. "The energy of absorption," say they, "is in an inverse ratio to that of the circulation; during *nausea*, the force of the circulation is generally abated." In other words, whatever increases the circulation beyond its accustomed momentum, retards absorption, and *vice versa*. And many years observation has proved, that the *virulence of certain infections* is greatly lessened in *hot and dry weather*; while, on the other hand, they are greatly increased in *hot and wet weather*.

I shall now endeavour to trace to their proper sources, or causes, the various phenomena of the Creation; and by attending to the influences of the primary agents in all the processes of nature, shall prove them to be the active causes of all her phenomena in the firmament or in the earth.

My first position, sec. vi. page 14, is, that "It must be admitted *a priori*; that the primordial matters of the Creation, were blended together in a state of fluidity, intermediate between the liquid and gaseous states, constituting a chaotic

cloud of dense vapour, and holding in solution the integrant essences or principles of those substances that were to be created, but which were then and previously 'without form and void.'” This position is in accordance with the theory of WERNER and his followers, (sec. vii. page 16.) The reasons which have influenced me in the adoption of this opinion, are derived from the results of chemical and electro-chemical processes in the analysis of all the substances of nature; from whence, I have inferred, that in the development of the numerous phenomena observed in these analyses, and in the recent discovery of so many *gaseous* and other substances formerly unnoticed, or unknown; that these substances had, nevertheless, or, at least several of them been regularly, though imperceptibly, developing themselves in the grand atmospheric and subterranean, as well as oceanic processes, which nature, by her established laws, had been carrying on in her universal laboratory, from the beginning until now. And these reasons have acquired weight from the remarks of *Professor CLEVELAND*, in his observations on volcanic productions, where he says, “The heat of volcanic mountains, even when not in a state of great activity, is sufficient to produce a continual disengagement of *sulphurous acid gas*, which, combining with more *oxygen*, may pass to the state of *sulphuric acid*. These acids attack and penetrate the lava, render it lighter and more brittle, and usually change its colour to white or yellowish white; in fine, by their combination with some of the ingredients of the lava, several saline compounds are produced; among these, are the *alkaline sulphate of alumine*, and the *sulphates of lime, magnesia and iron*.” (*Elementary Treatise on Mineralogy, &c.* vol. 2, p. 770.)

The same, or similar processes, are unquestionably going on in the subterranean recesses of the earth; great and wonderful effects are produced in the mineral kingdom, by *pseudo-volcanic* explosions; gases are evolved; minerals decomposed, and metals are fused, by the intense action of fire. Again, similar effects are produced by *sub-aquatic* processes, in which the three primitive substances, fire, earth and water, are engaged. Hence, without adverting to the universal existence of the *muriate of soda*, or common salt, imbedded in all parts of the globe, these sub-marine explosions are suffi-

cient to account for the generation of *muriatic acid* and *chlorine gases*, whose union with other bodies are productive of various fluid, liquid and solid compounds. And the same argument applies with equal justice to all the recent discoveries in chemistry. For, although the ingenuity of man has devised processes for the production of many unknown substances, by various chemical combinations, and has appropriated to them terms indicative of their derivations, it will not surely be contested, that because these substances were unknown as such to former ages, as also the processes for their production, that *azotic*, *carbonic*, *nitric muriatic*, *sulphuric*, and indeed all other *gases*, had not existed in nature, or had not been evolved, and evolving ages on ages before they were detected by art, and experimentally known in practice.

So also of the more recent discovery of *potassium*, *sodium*, *calcium*, *barium*, *strontium*, *magnesium*, *yttrium*, *glucinum*, *aluminum*, *zirconium*, *thorium*, &c.; although existing in the various earths of which they are respectively the metallic bases, ever since the formation of those earths, they were still hid in the profound *arcana* of nature, until the genius and enterprize of CHAPTAL, LAVOISIER, BERZELIUS, DAVY, and other eminent philosophers and chemists, detected and brought them to our knowledge. But will it be contended, that these metallic bases, thus named by their discoverers, did not exist in nature previous to such discovery? Or, might they not have been produced to greater perfection, by the myriads of operations carried on in the bowels of the earth, by the action of the two great physical agents upon those earths producing these metallic bases, and indeed with all the metals with which we have been made acquainted.

To the accidental discovery of GALVANI, we owe one of the most important agents in chemical science, that of the arrangement of metallic bodies, by which the most powerful effects are produced on all substances submitted to its influence. But, can it be honestly believed, that arrangements of metallic bodies, such as *gold* and *zinc*, or *silver* and *zinc*, *copper* and *zinc*, &c., since termed *galvanic arrangements*, as a just tribute to the fortunate discoverer, have not, in innumerable instances, occurred in nature? And who can doubt, that many volcanic eruptions and pseudo-volcanic explosions, are caused by electric and electro-galvanic operations, em-

ployed by nature for acting upon different earths, singly or variously combined, and by whose agency, all ores discovered and undiscovered are produced? It has been by electro-chemical agency, that SIR H. DAVY and others, have obtained the foregoing metallic bases; and I contend, that nature has, by the same agency, produced not only metals, but all orders of bodies in our globe.

It is but honest, then, to admit, that in the primordial mass of matters of which the universe was to be made or created, the wisdom and power of the CREATOR! had amply provided every means for the production of all causes and effects, and the contingencies connected with each. (*Axioms 1, 2 and 3, page 7.*)^{*} And that hence, the laws that have been ascertained as governing all bodies in their *action, re-action, affinities*, simple and complex, in their *binary, ternary and quaternary* combinations, in their distinct and specific characters, whether as agents or subjects; as earths, metals or minerals; in their gaseous, liquid or solid states; in the variety and structure of their crystals, their colours, flavour, properties and uses; in short, in every thing connected with nature; practical chemistry has, step by step, unfolded and discovered to the world, the principles and processes which nature has been pursuing, at all times, and in all ages, since the world was created. There is, therefore, no natural cause or effect, no phenomenon in chemistry, that has not been anticipated and provided for in the great laboratory of nature, by the AUTHOR AND CHEMIST OF WORLDS!

We must, therefore, take it to be granted, that nature was amply provided with every requisite material, and her agents endowed with adequate powers for performing all the processes connected with the creation of the world, and ever since, in conformity with the DIVINE WILL; when, by the quickening and vivifying influence of HIS HOLY SPIRIT! moving upon the face of the waters, He imparted life, or a principle of action, to all orders of bodies, whether vegetable, mineral, or animal; and, that there was assigned to each class, the principles necessary to their production, reproduction, and increase; and, that He had established for them, permanently and immutably, the laws by which all the bodies in the universe have since been governed.

Influenced by these *facts*, that have been established by all the phenomena in nature, and which are confirmed by every day's experience, I have assumed them as the principles upon which my Theory of the Earth has been founded; and of which, the following are among its principal features.

1. The two antagonist agents of *light and heat*, and of *darkness and cold*, are the primary sources and causes of all the phenomena of nature.

2. That OXIGENE, or primitive electric light, is the generic source of all those ethereal fluids, by which the *expansion* and *rarifaction* of all bodies susceptible of expansion is effected; that these fluids are recognized in the decomposition of the solar beam, in which they exist singly, as *light*, heat (*caloric*) and *electricity*, conjoined as *oxicaloric*, or the solar oxidizing rays, from whence originates *oxygen*, or the acidifying principle of nature, and the base of vital air.

3. That NITROGENE, or the ethereal fundamental principle of darkness, is the generic source of those ethereal fluids, by which the *contraction* and *cohesion* of bodies is effected; that these fluids are also recognized in the solar beam when decomposed, and in which they exist, singly, as *darkness*, *cold* (*frigoric*) and *magnetism*, conjoined as *nitro-frigoric*, or the solar deoxidizing rays, from whence originates *nitrogen*, or the alkalinizizing principle of nature, and one of the constituents in atmospheric air.

4. That these primary and antagonist fluids, together with their species, either singly or combined, were the AGENTS, by which all the processes of the Creation were governed; that those portions of the primordial mass of matter, since recognized as constituting the three kingdoms of nature, were the SUBJECTS; and WATER, whether in its *aeriform* or liquid state, was the UNIVERSAL MENSTRUUM of nature.

5. That the firmament or *heaven*, was formed by the conversion of one portion of the chaotic mass to OXIGENE and NITROGENE, the two great physical agents, that constitute the pabulum or fuel of the sun and stars; that solar light is a compound of these fluids, elaborated and assimilated to their natures; that the atmosphere of our globe was formed by the conversion of another portion of the primitive matters of the Creation, through the influence of these agents; that our

globe or earth was formed by the precipitation and gravitation of its substance towards its centre, where, by a law of nature, and the coercive and cohesive influence of NITROGENE, it acquired solidity and constituted the *nucleus*.

6. That the waters were superior to the earth, until, by the DIVINE COMMAND, they were gathered together unto one place, in order that the dry land should appear.

7. That the subsidence of the waters of the ocean has continued from the Creation until now, with the exception of those periods in which some great catastrophe, or some sudden changes have taken place,* that the solid parts are continually increasing at the expense of the fluid; that a period will arrive, in which the solid parts will be superior to them; and finally, that the processes of nature, influenced and governed as at the Creation, by these agents and species, will continue to produce their effects upon all orders of bodies, in the vegetable, the animal, and the mineral kingdoms, until it shall please the Supreme Governor of the Universe, to countermand them, and to put an end to Time. And

8. I consider our globe to have changed its axis in consequence of some overwhelming force, correspondent to that noticed in the note below, that hence, the poles of the earth are not correctly north and south; that the earth, exclusively of her annual and diurnal motion, has a vibratory motion or swing, which brings her poles either to the east or west of the polar star, within certain periods alternately; and that from this cause the magnetic needle is said to vary; when, in fact, it is the earth itself which varies, and thus changes the position of the magnetic meridian; for every good and perfect needle, is governed by the principle of polarity in the air and in the earth, and is hence true to the pole of the earth, while it does, with the magnet meridian, vary from the polar star. This subject is treated at length in my 4th lecture on OXYGENE, or the elements of electricity, accompanied with a diagram.

* By these are meant the Mosaic deluge and the flood, supposed by Mr. KIRWAN as occurring at some remote period from the south-east, tearing up and bearing away the looser materials of the southern hemisphere, and bringing a great body of them to the northern, impressing upon the Capes of Good Hope, of Horn, of Van Diemens, and other promontories, the marks of its overwhelming force.

XLIII.

On the uniform subsidence of the Ocean.

We have already seen, sect. xxxvi. page 95, and sequel, that transition rocks, in every part of the globe, contain organic remains of vegetable and marine productions; and the inference drawn from this phenomenon, by the most learned and experienced naturalists, is, that the waters of the ocean must, at a time previous to these deposits, have been superior to these mountains; some of whose summits are now found to be considerably elevated above the level of the sea. The most remarkable natural evidences of the slow and gradual subsidence of the ocean, and increase of land, present themselves in the abandonment or destruction of the ancient maritime cities. The formation of mountains, the discovery of the various depositions of the sea, and the uniformity of the character of these depositions in the same species of the strata of the earth; in the petrifications and fossil remains of vegetable and animal substances of classes and orders unknown to the inhabitants of the postdeluvian world.

However variant the opinions of geologists and naturalists as to the agents of nature, all are agreed as to this point, the universal envelopment of the earth by the waters of the ocean, and their continued subsidence from the Creation until now. The learned CUVIER says, "It is impossible to deny, that the waters of the sea have formerly, and for a long time, covered the masses of matter which now constitute our highest mountains; and further, that these waters, during a long time, did not support any living bodies." "Whatever might have been the elevation of the waters above our mountains," says M. DE MAILLET, "they did not then contain shells and fish." Indeed, most writers on this subject, appear to have arrived at the same conclusions, from the discovery of the same, or similar phenomena, connected with the deposits and formations of the different materials of which the crust of the earth is composed. In fact, there are no records more decisive, no delineations more correct; nor are there in nature any proofs more conclusive towards the establishment of facts connected with natural history, and particularly this branch of it, than those that have been permanently stamped by the unerring hand of the CREATOR upon this globe:

every strata of which, penetrated as yet by the enterprising genius of man, from the lowest accessible bed of the ocean, to the summits of our highest mountains, serve as so many pages of the most authentic records of the commencement, progress, and important events or changes in the stupendous volume of the Creation; every one of which tend to the confirmation of these facts, the entire envelopement of the globe at some period of time, by the waters of the ocean; and their subsequent and continued subsidence ever since.

Historians inform us, that the *Lybian deserts* which terminate Egypt to the east, were once occupied by the waters of the ocean; and the remains of ancient cities, now buried under heaps of sand, were once flourishing sea-ports. In the days of HERODOTUS, there were rocks near the ancient city of *Memphis*, in which there were rings of iron for securing their shipping. Notwithstanding this, *Memphis* is, at present, twenty-five leagues from the sea; and, according to DR. CLARKE, its scite is now occupied by two small villages. Five successive cities have risen on the margin of this sea, the first towards *Nubia*; this being abandoned by the sea, a second succeeded, and to this three others, one of which was famed for containing the temple of JUPITER AMMON, which was built in the time of ALEXANDER and the Romans; and this last by the city and port of *Alexandria*; this port is now fast filling up. The *Castle of Rosetta*, formerly contiguous to the shore, is now upwards of a mile from the sea; and the *Fortress of Damietta*, formerly at the mouth of the Nile, is now some miles distant from it. And in consequence of the continued diminution of the sea, the merchants of *Alexandria* will be obliged to forsake it, and to look out for a new harbour for their shipping. (DE MAILLET.)

There can be no circumstance more strikingly corroborative of the remarks above noticed, than the facts, that the people who reside contiguous to the deserts, still retain the ancient names of these seas. Thus, they say, the sea of *Barca*, *Borneo*, *Cyrene* and *Jupiter Ammon*, in order to give the proper names to the beds or channels in which these seas once ran. Geographers themselves retain these very names in their charts and maps, being sensible that they have preserved them, ever since they have been occupied by the waves of the Mediterranean, though now sandy and barren deserts.

Numerous and similar proofs of the subsidence of the ocean in *Asia*, *Africa* and *Europe*, are to be collected from the writings of both ancient and modern geologists and naturalists, particularly those of DE MAILLET, CUVIER, SAVARY, JABLONSKI, CLARKE, and others; and of *America*, north and south, those of HUMBOLDT, MITCHILL, RAMSAY and DRAYTON. The original saltness of the great lakes, or inland seas of North America, and those of South America, termed the Mexican Lakes, offer, in the abundance of the marine relicks, which every where surround the former, and the still brackish qualities of the latter, strong proofs of their having been formerly basins of the great ocean. Professor MITCHILL has shown, in the most satisfactory manner, the breaches that have, in all probability, enabled the lakes to burst their barriers, and to permit their briny contents to escape, and to accompany their parent source in its continued retreat from the shores; the remaining portion receiving, from time to time, large supplies of water from the sky, became more and more dilute, until at last they acquired their present freshness.

In South-Carolina, we have indubitable proofs of the retreat of the ocean, and the increase of soil. There can be no doubt, but that the whole of the lower country, from the Atlantic near the mouth of *Little River*, to the southern boundary of the state, to wit, the same ocean at the mouth of *Savannah River*, like the *Delta* of Egypt, has been gained upon the sea. The immense stratum of oyster shells mentioned, sect. xxxviii. page 102, extending from NELSON'S *Ferry*, at a distance of 60 miles from the Atlantic, and running in a line parallel with the sea towards the *Savannah River*, affords strong proofs, that these shells were deposited by the sea, at a time when her waters were superior to the scites which these shells and their superincumbent soil at present occupy. And from the discovery recently made by boring for fresh water in the city of Charleston, and recorded in RAMSAY'S *History of South-Carolina*; and again, by DR. MOSER, in the *Carolina Journal of Medicine, Science, &c.* for January, 1825, I have sufficient data for asserting, that the waters of the ocean were, at some former period, at least 1400 feet superior to the present surface of our city.

The elevation of the land in the upper district, has been affixed at 1132 feet above the level of the Atlantic ocean,* not

* DRAYTON'S *View*, p. 12.

however including the mountains, but the soil at their bases. Shells have been discovered at a depth of 314 to 317 feet below the surface of the soil on which Charleston is located. These must have been deposited there when the sea was superior to this stratum, and perhaps at the period when her waves were washing the feet of our mountains; in which event, her bed at the scite now occupied by Charleston, must have been 1449 feet deep; and while I confess that I am unable, by any regular system of calculation, to account for this phenomenon, the evidences in proof of the fact are, notwithstanding, undeniable.

M. DE MAILLET considers the sea to subside about three feet four inches in a thousand years;* and concludes, how difficult it is for a man, in the ordinary course of life, of fifty or sixty years, (for we must be twenty before reason is duly formed) to distinguish this insensible diminution amidst the flux and reflux of the sea, and the perpetual agitation of her waves, caused by the winds and currents, which sometimes raise them in one part, while they diminish them in another. To these difficulties add, that those that have gone before us, died ignorant of this diminution, for want of having thoroughly studied the composition of the globe, and comparing what passes daily on the shore of the sea, and in her bosom, with what we see, from her coasts to the summits of our highest mountains. To these obstacles add, that our reason is reduced by the position of certain cities of very ancient names, which we know to have been situated on the sea shore in very distant ages, and which we find situated there still. People are not at the pains to observe, that these are the names, but not the ancient situations of these cities; for the inhabitants of maritime places, at first extend their habitations on the grounds which the sea uncovers, as being most near to her, and consequently most favourable to commerce; so that cities change their positions by following the sea, without changing their names, and without their change of place being perceived. It is, therefore, not surprizing, that the diminution of the sea, and the true origin of our globe, have remained so long unknown to the most of the human

* This is considered to be an error, perhaps typographical, and instead of a thousand years, should read one hundred, or a century.

race, notwithstanding all the circumstances in nature which point them out.*

In the Swedish Transactions for 1823, an account of the subsidence of the waters of the Baltic has been published, and the subsidence has been ascertained by M. BUNCRONA, to be from latitude 56 to 63 deg., a mean fall of one foot and a half in forty years. In the gulf of *Bothnia*, the results are more uniform, and indicate a mean fall of four feet four inches in a century, while that in latitude 56 to 63, is only three feet ten inches in a century. With these allowances, it will be seen, that it would require a lapse of 290 centuries, before the sea could, at this rate, have retired from the foot of the table mountain in Pendleton district, to its present level at the wharves in Charleston. We are compelled, therefore, independent of its regular subsidence, to attribute to other and unknown causes, the extraordinary decrease of the ocean which nature every where evidences, in the depositions already noticed, and the various formations that have been added to our globe since its creation; of which, the lower district of South-Carolina has been offered as a fair example.

XLIV.

Reasons offered for the adoption of the opinion of the universal influence of the Deluge.

The sacred records of the Holy Bible, when faithfully examined, afford such ample testimony of their DIVINE origin, that were there no other proofs accessible to us, than those that are recorded in the 6th and 7th chapters of Genesis, with respect to this important event, these records alone are sufficient to establish the fact. But, to the discriminating naturalist, the most palpable evidences are to be discovered in the various phenomena that have developed themselves in proportion, as their researches have been extended in various sections of the globe. These phenomena, so similar to each other, and yet so widely extended, is, at least, one proof of the universality of this awful catastrophe.

Without, therefore, entering into the merits of the controverted opinions entertained on this subject, and the supposed proofs said to be drawn from the inundations of Thessaly and Greece, and which have given rise to the fable of *Deucalion*

* Telliamed, or the World Explained; pp. 152, 3.

and *Pyrrha*, or of the more ancient deluges of *Osiris* and *Ogyges*, I shall proceed to offer the reasons that have influenced me in the adoption of the opinion, that the deluge recorded by *Moses*, influenced the whole globe.

It is very common, says M. DE MAILLET, for those who travel through the sandy deserts of Lybia and Africa, to find in digging wells, small pieces of petrified ships, which were no doubt wrecked when the sea covered these parts. They also find a great many pieces of petrified wood, which are probably the wrecks of some other similar ships. About a day and a half, or at most, two days' journey to the westward of Cairo, there is in the middle of the desert of sand, a pretty long valley bounded and interspersed with rocks, and at present partly filled with sand. This place is called by the Arabs *Bahar Balaama*, that is, without water, because the place is dried up. In it, are found a great many barks and ships, which had been formerly wrecked, and are now petrified. We there find masts and yards, many of which are entire.

The fossil organic remains of CUVIER, of WEBSTER, and of MITCHILL, which I have noticed, sect. xxxvii., afford sufficient grounds for believing those remains of extinct quadrupeds, to have been an effect of the great deluge. The immense number of the bones of *bears* found in the limestone caverns of Germany and Hungary, to the extent of 200 leagues; the amazing number of teeth, jaws and bones of *bears*, *hyenas*, *lions*, *tigers*, *dogs* and smaller carnivorous animals, hundreds of cart-loads of which, according to ESPER, are found in the caves of *Gaylenreuth*, renders it highly probable, that these groupes of animals, generally at variance with each other, but here found promiscuously mingled in one mass of ruin, must have been driven by the rising of the waters, to fly for shelter within these immense caverns, in which they were drowned.

But CUVIER and JAMESON are of opinion, that "these bones could not have been introduced into the caves by the action of water, because the smallest processes or inequalities on their surface is preserved. It is, therefore, conjectured, that the animals to which they belonged, must have lived and died peacefully in the spot where we now find them."* With

* Mitchill's ed. Jameson's *Cuvier*, pp. 242.

due deference to this opinion of the foregoing authors, it appears to me, that a moment's reflection on this subject, will operate in favour of the opinion which I have assumed in preference; to wit, that these animals were, of necessity, driven to take shelter in the caverns, as the waters of the deluge were increasing; that being consequently drowned all together in them, their carcasses were left entire on the subsidence of the waters, and the flesh corrupting in time, left the bones, "with their smallest processes or inequalities," perfectly preserved; indeed, I know of no method by which they could have been better preserved, than by the slow and gradual decomposition of their flesh, in so soft and yielding a substance as water.

I believe it is a rare and uncommon occurrence for animals of the above description, generally hostile to each other, to groupe or associate in the manner in which their remains have been found. It is, therefore, rational to conclude, that they were thus associated from necessity, by some gradually advancing calamity from which they retreated, until arriving within these caverns; and from the very circumstance of their being found together in these caves, and to such an amazing extent and number, it appears evident, that their retreat must have been from various localities of their wilderness haunts to those caverns, in which they were drowned *en masse*. It is a well known fact, that in the American forests, plans are laid for grouping and entrapping deer, &c., by firing the grass to an extensive circle of many miles. The affrighted animals make a precipitate retreat from the fire, and thus collecting in every direction, from a circumference to its centre, immense groupes of all the animals within this circumscribed limit, fall an easy prey to their destroyers.

Another circumstance, which affords sufficient arguments in favour of the universality of this deluge, is the former extensive existence of the extinct *mastodon* or mammoth; the bones of which extraordinary animal have been shown, sect. xxxix., to be distributed in every section of the habitable globe, in which geological researches have been made; and in places to which the waters of the ocean could not possibly have had access; and this distribution of these animals, must decidedly prove one, of two equally conclusive facts. 1st. Either, that the carcasses of these extinct quadrupeds, that are

said to be natives of eastern countries, must have been deposited in the places where their remains are now found, by the overwhelming waters of the deluge, during their subsidence, by which they were scattered all over the earth in her diurnal revolutions, and have been since covered over by alluvial soil; or, 2dly. That they must have been natives of all the parts of the earth in which their remains have been discovered, and that they were drowned, or otherwise destroyed by some peculiar occurrence, common to all parts of the globe, and at the same period of time.

Both the foregoing propositions will terminate in favour of the universal influence of the deluge. In either case, the remains of these animals occupy the same, or nearly the same, geological situations; to wit, alluvial formations of contemporaneous dates; and these, generally, from ten to twelve feet beneath the surface of the earth; and M. CUVIER, aware of this important fact, very judiciously distinguishes between the epochas, which mark the deposits of the extinct genera of quadrupeds, &c., from those of the presently existing genera, which he does, with the following appropriate conclusion: "The facts hitherto collected, seem to announce, at least as plainly as two imperfect documents can, that the two sorts of fossil ruminants belong to two orders of alluvial deposits, and consequently to two geological epochas; that the one have been, and are now daily becoming enveloped in alluvial matter; whereas the others have been the victims of the same revolution which destroyed the other species of the alluvial strata, such as *mammoths*, *mastodons*, and all the *multungula*, the genera of which now exist only in the torrid zone."

These circumstances, more than any others of similar characters, confirm the MOSAIC account of the deluge. The *elephant*, *rhinoceros* and *camels*, were originally numerous in Asia. The remains of the former have been discovered in all parts of the world; and in *Asiatic Russia*, more abundantly than elsewhere, they are strewed beneath the alluvial soil from the *Don* to *Tchutskoinoss*. "There is scarcely a river," says PALLAS, "the bank of which does not afford remains of the Mammoth." At present, no living vestige of them is to be found in any part of the globe, except *Asia* and *Africa*, the very theatre in which this fatal catastrophe is recorded particularly to have happened. How, then, shall we rationally

account for this indisputable fact, that the remains of the Elephant or Mammoth, are found buried in the alluvial soil of Europe and America; in neither of which countries, there are now any living species of these genera of animals to be found? And how could they, or at least the elephants, to which they have been proved to be very nearly allied, be still existing in Asia and Africa, if they had not been thus providentially preserved in the ark, for the future production of their species?

It has been objected, and may be again opposed to the foregoing conclusion, that, as NOAH was commanded, "Of every clean beast thou shalt take to thee by sevens, the male and his female; and of beasts that are not clean by two, the male and his female; of fowls also of the air by sevens, the male and the female, to keep seed alive upon the face of the earth," (Gen. chap. vii. v. 2, 3,) that *mammoths* must have been included among the number of the beasts contained in the ark; and it is inquired, what has become of them at this time? I can offer no more appropriate reply to this very reasonable inquiry, than by referring to the vast number of *extinct animals*, an abridged account of which, will be seen, sect. xxxvii. It is possible, that these antideluvian animals might have become extinct, just previous to this great revolution in nature; in which case, there could have been none of their genera contained in the ark; and this is rendered still more probable, when it is considered, that most of the fossil remains of these extinct genera of quadrupeds, have been proved to be of more gigantic statures, than any of the present generations; and it has been also satisfactorily proved, that the *extinct mammoth* is very nearly allied to the *existing elephants* of *Asia* and of *Africa*, &c.

Again, on examining the fossil teeth of these animals, it will be perceived, that they belong evidently to two distinct species; for, "Among them were grinders, bearing all the marks of a *carnivorous animal*, having double rows of high blunt points or protuberances, as if intended to masticate, and not to grind the food. Others were of a different and much larger texture, apparently belonging to a *graminivorous animal*. They were flat and ribbed transversely on the surfaces, resembling, according to the accounts of naturalists, the grinders of an elephant." (DRAYTON.) Of the elephant or mammoth genus, "Two species are, at present, known as

inhabitants of the earth. The one which is confined to *Africa*, is named the African elephant; the other, which is a native of *Asia*, is named the Asiatic elephant. Only one fossil species has hitherto been discovered; it is the *mammoth* of the Russians. It differs from both the existing species, but agrees more nearly with the Asiatic than the African species." (JAMESON.) It is, however, added in a note, that "these three species are well distinguished by the appearance of the surface of the grinding teeth;" which corresponds precisely with what Governor DRAYTON has said, of their belonging to two distinct species of animals, the one carnivorous, the other graminivorous.

Among the fossil bones sent by Governor CLARKE to MR. JEFFERSON, President of the United States, there were "Two kinds of teeth of very large size, and detached from the jaws; some of these teeth evidently belonged to the *mastodon*, being distinguished by their elevated processes; while others more nearly resembled the elephant's grinders." (MITCHILL.) From these facts, it would appear, that the mammoths were carnivorous animals, and distinguished as such from the elephants, by their grinders having elevated processes, while those of the elephant were flat, indicating them to belong to animals of the graminivorous or herbivorous species.

Upon the whole, therefore, I do not discover in the foregoing objection, sufficient grounds for relinquishing the opinion of the universal influence of the deluge. The extinction of the *mastodon* genera, cannot afford sufficient arguments for the objection, on the grounds of their having been a pair of them preserved in the ark; for, I have already shown, that there are several genera, and many species of animals besides mammoths, that have been proved to be now extinct; whence, it is inferred; that the entire classes and orders of these animals, had become extinct previous to the *Mosaic* deluge; and of the species allied to the *mastodon* genera, the two species at present known, were only among those that were received into the ark, and hence perpetuated their species. But to return.

In the geological essays of RICHARD KIRWAN, Esq. *F. R. S. &c.*, with respect to the deluge, a similar opinion is advocated by that learned naturalist. He considers, that the gradual subsidence of the waters of the ocean continued from

the Creation, until a few centuries before the general deluge; that this event was occasioned by a miraculous effusion of water, both from the clouds and the great abyss—the latter originating in and proceeding from the great southern ocean below the equator, and thence rushing on to the northern hemisphere, spreading over the arctic region, and descending again southward; that during this elemental conflict, the carbonaceous and bituminous matter ran into masses no longer suspensible in water, and formed *strata of coal*; and that other substances, by the combination or decomposition of their respective materials, formed various other kinds of mineral bodies, as *basaltic masses, calcedonies, spars, &c.* (See ACCUM'S System of Theoretical and Practical Chemistry, vol. 1, p. 37.)

DR. BURNET, in his *Telluris Theoria Sacra*, published in 1680; MR. WHISTON, in his *New Theory of the Earth*, 1690; DR. WORTHINGTON'S *Scripture Theory of the Earth*, 1773; M. DE LUC of Geneva, *Sur L'Histoire de la terre*, &c. 1780; each advocate the Mosaic account of the universal deluge; and it is conceived, that the proofs which have been advanced in support of this opinion, are more conclusive than any facts that might be marshalled in support of the contrary opinion.

XLV.

Remarks on the Comet of 1825.

I have no design of entering into any of the numerous fields of conjecture concerning comets; the object of the present section is, merely to state my observations on this, which made its appearance in our hemisphere on the 13th of September, 1825, and its influence on our atmosphere.

This body became somewhat visible at Charleston, on the 13th of September, but in consequence of the unsettled state of our atmosphere, perhaps influenced by its approach, it was not perfectly visible to the naked eye until the 18th; I did, not, however, succeed in collecting its rays until the night of the 4th October. * The entire image of the comet, as represented by the prism, was inverted; and its visible atmosphere or stream of light, commonly called its tail, was thrown as it were, vertically towards the earth; the body appeared of a very dark or deep red colour, similar to an ignited globe; the stream or tail, for an apparent space of three inches, next

to the body of the comet, was of a deep or orange yellow; another belt of three or four inches below this, was of a paler yellow; and the remaining part, apparently two yards in length, of a pale bluish green.

In decomposing the light of the moon, I had most commonly succeeded in obtaining all the prismatic colours of the solar beam. In attempting to decompose the light of the fixed stars, I have ascertained, that they present none of the colours of the solar light, but pure uncombined OXIGENE, or primitive electric light; and are hence visible to us from the intensity of their own light, independent, perhaps, of the light of the sun, and that their light is indecomposable. The lights of the planets are decomposed, and present the same number of colours that have been detected in this comet, though considerably paler, and requiring a strong sight to distinguish them with accuracy. These experiments were pursued every night from the 4th to the 18th of October; on which night, for the last time, I succeeded in obtaining the same invariable results from the prism. This body having then retired so far to the south, and the intensity of the moon light, in some measure preventing further accurate observations, I thought proper to decline any further attempts upon it.

From the circumstance of its presenting the same number of colours that the planets do, to wit, red, orange, yellow, and a pale bluish green; and from the circumstance of its light differing from that of the fixed stars, I am induced to believe this comet to be nothing more than an *erratic planet*, moving from sphere to sphere, revolving around its own axis from east to west, within the period of a solar day, a direction contrary to the fixed stars, and to our earth, which revolves from west to east. Its revolution is, therefore, with the sun; and its light is reflected from that luminary. That the motion of the present comet is from east to west, is proved from the fact, that at nine o'clock, P. M. its atmosphere or tail is considerably inclined to the east; at twelve o'clock, or midnight, it is vertical; and at three o'clock in the morning, it is inclined several degrees to the west.

The claim of this ethereal visitant to the appellation of a comet, says a writer in the Richmond Compiler, is deemed problematical, by reason of its not launching forth into the

boundless regions of space, millions of miles beyond the most distant known planet of our system, but performs its revolutions within the orbit of Saturn; and its period differs but little from that of the four newly discovered planets, being 46 days less than that of *Vesta*; and is supposed by *OLBERS*, to have had a common origin with them. This supposition, says the same writer, derives support from the fact, that its period of return is lessening with every revolution, as well as by the circumstance, that *Ceres* also has a cometary appearance, *but* is, nevertheless, classed among the new planets. The influence of this body upon our atmosphere, during its *perigee* from the 18th September to the 18th of October, particularly as it regards its electrical state, claimed my particular attention. Before I was conscious of its appearance in our hemisphere, my attention was drawn to an unusual phenomenon in electricity. On the 13th of September, the day cloudy with light sprinkles of rain, the mercury rose in my electrical room to 82 deg. *Fahrenheit*. From then to the 26th, it attained daily a height of 86 deg. On the 25th, we had a copious fall of rain, accompanied with heavy concussions of thunder and lightning, and the mercury sunk to 76 deg.; during this period the fluid was *minus*. There was a kind of air circulating in the atmosphere, which appeared to be composed of heat and moisture, in proportions and intensities peculiarly inimical to electrical operations; a kind of *arid moisture*, which seemed to blunt or absorb the *OXIGENE* or electricity of the air, so that it was not easily collected, and when collected, could only be transmitted in sufficient strength to the patients, by the interposition of the living fibres, which were made the conducting medium from the prime conductor to the patient, and that more readily than by the usual mode.

This peculiar influence in the atmosphere continued from Tuesday, the 13th September, when the comet was arriving at its *perigee*, to Saturday, the 15th of October, when it began to approach to its *apogee*. The weather became immediately cold, and in three days the mercury fell from 76 deg. to 50 deg., and the electric fluid was again transmitted through the common conductors with its usual facility. From hence I have been led to conclude, that as this peculiar phenomenon commenced with the approach, and declined with the departure of the comet, it must have influenced our atmosphere to

a degree capable of producing this phenomenon; and I can only add, that it has taught me an important fact in medical electricity, a desideratum in this damp and fluctuating climate, that when the fluid is *minus*, and in this state cannot be communicated to the patient in the ordinary way, by reason of the intervening air of the room, it may be advantageously communicated, provided the operator himself becomes the medium of communication, by placing one of his fingers on the affected part of the patient, who must be connected with the outside coating of the jar, while the operator occasionally discharges it, by applying the knuckle of the other hand to the prime conductor.

✎ As the publication of these sketches has been delayed in consequence of various unlooked-for disappointments, to this date, May 12th, 1826, I avail myself of the opportunity thus afforded to remark, that the present year has commenced with an atmosphere loaded with vapours, differing but a shade from that which existed during the influence of the comet, and has thus enabled me to confirm the foregoing remarks with regard to the transmission of the electric shock through the living fibre, when it cannot possibly be conveyed by any other conductor to the patient, in consequence of the humid state of the atmosphere.



✎ *Directions to the Binder.*

The plate of Diagrams and Scale to be placed between the 18th and 19th pages; the copper-plate impression to face page 18; the printed Scale 19.

INDEX.

A.

	PAGE
ACIDS, Analysis of	50
— reduced to their Primitives,	79.
Acidity, Principle of	23. 48
Action, Cause of	11. 15
Aerolites,	106
— are of Electrical Origin,	107
— contain only Magnetic Metals,	108
—, Analysis of their Substances,	108
—, Probable cause of their Projection,	110
Air, the gaseous form of Water,	13
—, Metallic Substances suspended in	13
—, Atmospheric	14
Affinity, Chemical	70
Agents, Two Primary Physical	9. 116
Alkalies, reduced to their Primitives,	80
Alkaligen,	23. 52
Alkaline Earths,	87
— Salts with Earthy Bases,	87
Alkalinity, Principle of	23
— not caused by Oxygen,	49
— produced by Nitrogen,	52
Alumine, Supposed origin of	84
Analogies, JENNINGS' View of	24
Analysis, Chemical, imperfect,	53 88
— of Acids,	50
— of Alkalies,	56
Animal Life, what constitutes it,	67
Animals, Extinct Species of	97. 104
Atmosphere, Formation of	13
—, Supposed height,	46
—, How generating Diseases,	57
Attraction,	60
— of Gravitation,	61
—, a quality of bodies,	63
—, Electric	63
—, superior to Chemical Affinity,	66
—, Magnetic	68
—, Examples of	64
AXIOMS, governing this Work,	7
Azotic Gas, see Nitrogen,	52
Axis of the Globe changed,	122

B.

	PAGE
Bodies are different from qualities,	41
— ought to be distinguished,	41

C.

Caloric, Origin of	14
— occupies the red ray of Light,	20
— an ingredient in the Solar Light,	35
—, Definition of	35
— latent until entering the Atmosphere,	35
—, Chemical properties of	36
—, cause of Expansion and Repulsion,	36
—, its tendency to an Equilibrium,	37
— is absorbed by all bodies,	37
— is the cause of Fluidity,	37
— radiant, What	38
— occupies the lower strata of Air,	45
Centrifugal Force,	9. 59
Centripetal Force,	9. 59
Chemical Analysis, Origin of	12
— imperfect state of, by Man,	53. 88
— Affinities,	60. 70
— Neutralization,	71
— Combinations,	72
— Deposites,	16
Chemistry derived from Nature,	119
Classification of Etherial Fluids,	19
Cohesion a property of one Agent,	22
—, Attraction of	60
Colour of OXIGENE,	35
Colours, Prismatic	27
—, Properties of	30
—, Magnetic influence of	32
—, Diagram of explained	31
—, Table of	19
— changed by Combinations,	73
— observed in the Comer of 1825,	133
— in the Planets and Stars,	134

	PAGE		PAGE
COLD occupies the dark rays of Light,	31	Electrical operations natural in the	
—, its polarising property,	32	Earth,	119
—, controversial points noticed,	42	Electro-Magnetic Attractions,	65. 111
— is a positive Substance,	42	— Galvanic Operations, natural,	119
— an absorbent of Heat,	43	Elevation of Lands in South-Carolina,	125
— transmitted from the Sun,	44	Equilibrium, a fundamental Law of	
—, influence of explained	45	Nature,	64
—, abundant in the higher regions,	46	Etherial Firmamental Fluids,	19
—, its Chemical Agencies,	47	Excess of Oxygen produce Acids,	50
— is not a property of the Air, &c.	47	— of Nitrogen produce Alkalies,	50
Combinations, Table of	73	Expansion, Cause of	11
—, Colours changed by	73	Extinct Animals, Remarks on	97
—, Metallic	89	— Shells, &c.	101
—, Varieties of	90		
Combustibles,	88		
Comet of 1825, Remarks on	133	F.	
Crystals, Primitive forms of	76	Fire, Etherial	13
—, Secondary forms of	77	—, Material	14
— influenced by Light,	77	Firmament, Creation of the	13
— by Darkness,	76	Fish, Petrified	101
Crystallization,	75	Fixed Stars, their light indecom-	
—, Laws governing	77	poundable,	134
—, Diagram of, No. 2,	77	Forces, two opposite in Nature,	10
D.		Forms of Bodies, how changed,	73
DARKNESS, a Physical Agent,	21	Fossil Organic Remains,	95
—, Oxides of	21	— Remains of Quadrupeds,	98
—, a material Substance,	41	Fluids converted to Solids,	73
— absorbent of Light,	41	—, Primary Etherial	19
— influences Crystallization,	76	FRIGORIC, or the principle of Cold,	21. 42
Death, The natural cause of	67	—, antagonist of Caloric,	36
Deluge, Universal	127	— absorbs $5\frac{1}{2}$ times its quantity	
Deoxidizing rays of Light,	32	of Caloric,	43
— are Magnetic,	67	— renders Caloric latent,	43
Depolarising rays of Light,	32	—, Chemical properties of	47
Diagram, Fig 1, Explanation of	19	Frigorific Rays, (note,)	29
— 2, Explanation of	76	Fuel of the Sun and Stars,	12
— 3, Explanation of	45		
Disaffection, Chemical	60	G.	
Dry Heat, Remarks on	39	Gases, how formed at the Creation,	11
E.		—, Imponderable Etherial	19
Earth always in the craving State,	66	—, Ponderable	22
— one Primitive,	81	— hold in solution Metals,	109
Earths reduced to their Primitives,	80	Galvanism natural in the Earth,	119
—, increase of their number,	81	— cause of Earthquakes,	119
— considered to be Oxides,	82	General Axioms,	7
—, Combinations of	83. 85	Globe, its axis changed,	122
—, their bases in Solution,	83	Glucine, its rarity;	87
—, new, accounted for	87	Governing Principles of this Work,	7
—, Alkaline	87	Granite, an example of Cohesion,	61
Earthquakes sometimes caused by		—, its Constituents,	61
electricity,	27	Gravitation,	61
Electric Fluid considered to be Pri-		Great Mastodon,	99
mitive Light,	20	Green Ray of Light, Cause of the	35
— now termed OXIGENE,	26		
Electrical Phenomena noticed, 27. 65.	135	H.	
— Attraction,	63	Heaven, the Creation of	13
— superior to Chemical Affinity,	66	Heat, see Caloric,	35

	PAGE		PAGE
Heat, Dry and Moist	39	Motion, a primary principle of the Senses,	60
I.		——, a quality or principle,	59
Ice, Experiments with	43	—— is the effect of a Cause,	59
Infections, Atmospherical	57. 117	N.	
L.		Neutral Compounds,	56
Land, Formation of	15	Nickel, Iron approaching perfection,	114
Light, Primitive or Electric	10. 20	New Earths accounted for,	87
——, a primary Physical Agent,	19	—— Metals,	113
——, Solar, formation of	17	Nitrogen, supposed to be an Oxide,	21
—— differs from Primitive Light,	18	(note),	21
——, New Theory of	18	——, the principle of Alkalinity,	23
——, Oxides of	19	——, its properties investigated,	52
——, Prismatic Colours of	17	—— supposed to be a compound,	53
—— decomposed by the Atmosphere,	27	——, Our knowledge of imperfect	53
—— influences Crystallization,	77	—— affords Alkali to Potash,	54
—— induces the forms of Crystals,	77	——, examples of its influence,	57
—— of the Fixed Stars,	134	——, Important remarks on	57
—— of the Comet of 1825,	133	—— in excess produces Alkalies,	57
Lightning identified with Electric Fluid,	27	—— is an ingredient in many	57
—— magnetizes Metals,	32	Compounds,	57
Laws of Motion,	58	NITROGEN, a primary Physical Agent,	21
—— fundamental of Nature,	64	——, the principle of Darkness,	21
M.		——, properties of its Species,	22
Madrepores,	101	——, the principle examined,	40
Magnesia, its origin accounted for,	83	Nitro Frigorific,	21
Magnetic Iron, Sand, &c.	69	Negative Electricity explained,	66
—— Metals,	108	Nervous Fluid,	67
—— Needle true to its Pole,	122	O.	
—— Meridian,	122	Ocean, Continued Subsidence of	123
Magnetism,	21. 68	——, proofs of the same,	123
—— is negative Electricity,	70	——, Historical Facts of	124
Marble produced by Filtration, &c.	82	——, how much diminished,	127
Marine Shells,	101	——, South-Carolina taken as an	89
Mammoth, Bones of	104	example,	89
—— first discovered in South-	104	Ores,	89
Carolina,	104	——, their origin accounted for,	112
Mastodon, The Great	99	Oxaloric,	20
Maximum of Light, Heat, Cold, &c.	29	Oxides of Light and Darkness,	20
Metals magnetized by Lightning,	32	——, Distinctive characters of	31
——, Ores of	89	Oxidizing rays of Light,	20
——, Variety of	90	—— are Electric,	67
——, New, remarks on	111	OxIGENE, or the principle of Light,	19
——, their Affinities,	112	——, properties of its Species,	20
——, how volatilized,	112	——, combination of, with Caloric,	20
——, their peculiarities,	113	—— with Nitrogene,	21
——, Meteoric	113	——, its vital influence,	26
——, Magnetic	108	——, identified with Lightning,	27
——, Division of	114	——, its universality,	27
Meteoric Stones,	106	——, a new term for the Electric	27
Moist Heat,	39	Fluid,	27
Motion induced into Matter,	14	——, cause of all the phenomena	27
——, its Laws,	58	of Nature,	27
		Oxygen, the principle of Acidity,	23. 48
		—— not the cause of Alkalinity,	50

	PAGE		PAGE
Oxygen, its Chemical properties,	49	Secondary Etherial Fluids,	20
———, its excess productive of		Soda, its origin accounted for	84
Acids,	54	Solar Light, its formation,	17
———, said to be an oxide of Light, 31		———, its constituents, (scale,)	19
P.		Solidity, how produced,	16
Pabulum or Fuel of the Sun and Stars,	12	Solids converted to Fluids,	73
Peroxides of Light and Darkness,	20	South-Carolina, Fossil Remains first	
Petrifications, Primitive	91	found in	104
———, why different,	97	———, elevation of its Land,	125
Pression, a term for Electrical Attraction,	64	——— offered as an exam-	
Primary Agents,	9	ple,	127
——— Etherial Fluids,	19	——— experiments boring	
Prismatic colours of Light,	27	for Water,	125
Polarity,	21	Stalactites and Stalagmites, how pro-	
Positive and Negative Electricity explained,	66	duced,	82
Potash, Particular remarks on	54	Sun always in the giving state,	66
Primitive Earth,	81	Substances reduced to their Primitives,	78
——— Rocks,	91	Subsidence of the Ocean,	123
——— Petrifications,	90	Synopsis of the Etherial Fluids,	18
Platina, the most perfect state of Iron,	114	Scale or Table of Combinations, be-	
Protoxides of Light and Darkness,	20	tween	18, 19
Q.		T.	
Qualities generated by Chemical Affinity,	60	Theory of Light,	18
——— should be distinguished		Theories noticed,	115
from Substances,		Thermometers, Remarks on	48
——— misapplied in explaining		Thorina,	87
quantity,	41	Temperature, Remarks on different	47
Quere, an important one,	66	——— of the Animal System,	38
R.		Titanium, Oxide of	114
Radiant Caloric,	38	———, found on Sullivan's	
Rays of Light, Alternate influence of	46	Island,	114
Reasons assigned for present Theory,	25	U.	
Re-action, Cause of	15	Universality of Organic Deposites,	100
Reduction of Substances,	78	——— of the Deluge,	129
Repulsion,	64	Universal Menstruum,	79
Repulsive Principle,	13	V.	
S.		Variation of the Magnetic Needle,	122
Scheme of Classification,	19	Vegetable Petrifications,	95
Salts. Alkaline	87	Vegeto Nervous Fluid,	68
——, Metallic	90	Volcanic Phenomena,	118
Selenium, Remarks on	113	W.	
Senses, Rays of Light influencing	32	Water, its Constituents, &c.	74
Shells, Extinct Fossil	101	———, the Universal Menstruum,	79
———, Universal distribution of	101	Y.	
Silex, a Primitive Earth,	80	Yttria, its rarity,	87
———, its base not Metallic, (note,)	83	Z.	
———, held in solution,	83	Zircon, its rarity,	87
Siliceous Earths and Stones,	85		
Silicon, its resemblance to Boron,			
(note,) 83			





